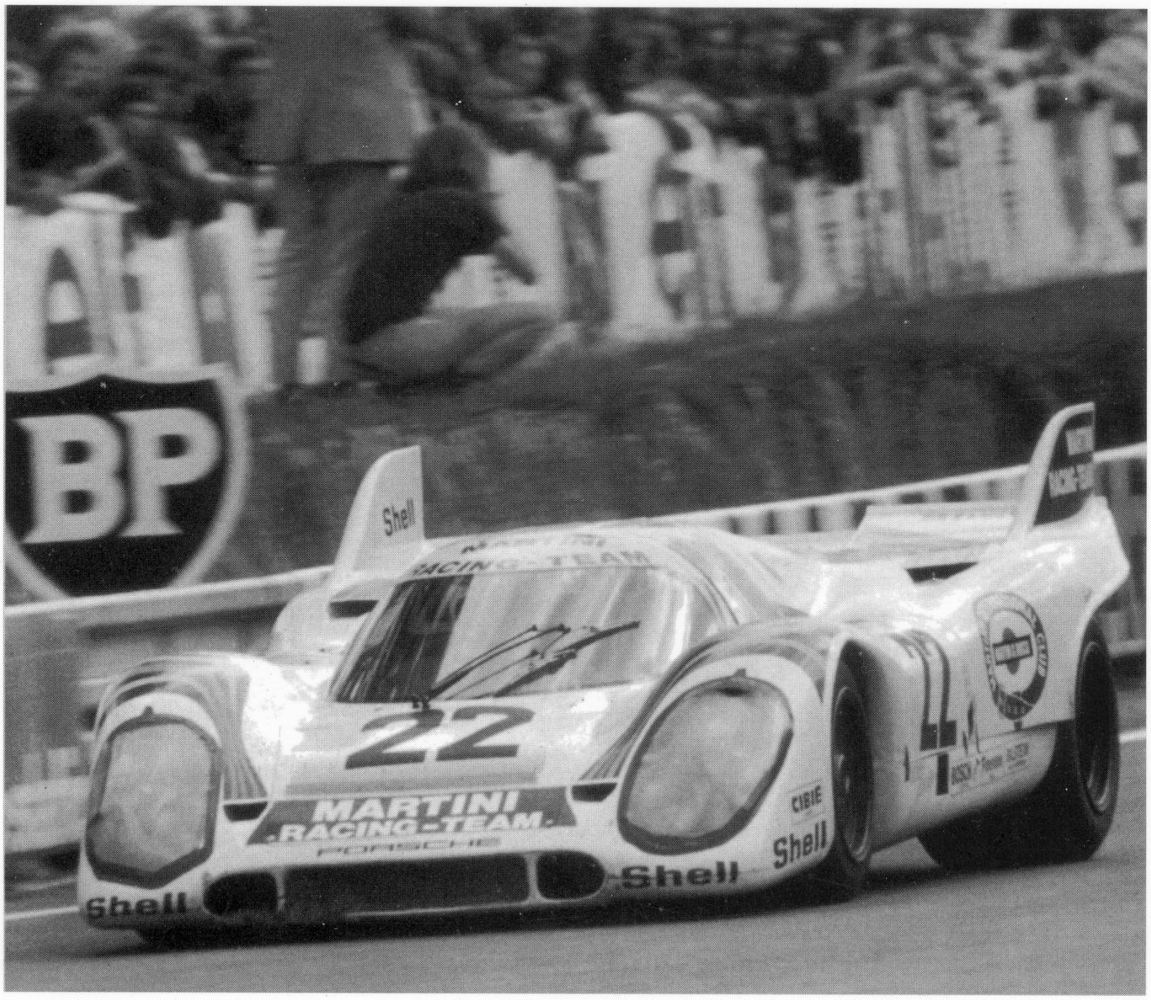
PORSCHE

917



THIS BOOK TAKES A LOOK AT THE PORSCHE 917 SPORTS RACER INCLUDING ITS SUCCESS AT LE MANS, AT THE SPA 100KM AND THE AUSTRIAN 1000 KMS. ALSO INCLUDED ARE CUTAWAY DRAWINGS OF THE 917 AND ENGINE DETAILS.

Porsche 917

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Porsche 917 Chassis Number 013/034

The Stoic Racing Porsche 917 started life as chassis number 917-013, but bears an additional 034, because it was necessary to re-chassis it after a substantial accident. Most of its successes were in 5-litre form, but it has now reverted to being a 4.5-litre, with 584 bhp and Le Mans gearing, which is good for 210 mph in top. It has had innumerable successes; in 1970, it came fourth at Sebring driven by Rodriguez and Kinunen, and the same team won at Daytona that year. In 1971 Rodriguez and Oliver repeated the Daytona victory, and the little Mexican took it to the chequered flag at Monza, Spa and the Osterreichring with Oliver and Attwood as partners respectively in Belgium and Austria. Bell and van Lennep finished second at Barcelona and completed the car's tremendous run by winning at Monthlery. The serous damage occurred during the filming of *Le Mans*, when the front was near enough written off, and was later used by the Kremer brothers as a basis for their 1981 917 – they had it for 10 months. It was acquired by its present owners, a consortium which included John Piper, directly from Porsche in 1974.

Porsche's Hard Charger

SINCE 1969, the power output of the Porsche 917 engine has been increased from 520 to about 1000 bhp, yet the engine and chassis are basically the same. This in itself is a remarkable feat, but is matched by the success of the car; World Champion Make in 1970 and 1971, and winning car in the 1972 CanAm series. Mark Donohue seems certain to win the CanAm Series with the latest 917.30 this year too.

Throughout its life, the Porsche 917 has succeeded because it has had plenty of power and has been reliable. And it came into being when Porsche took advantage of a typically short-sighted set of regulations produced by the CSI. In the late sixties, the CSI messed around no end with sports-racing categories and decided that, from January 1968, 3-litre prototypes would be the premier class, but that 5-litre "production" cars would be permitted.

This ruling was intended to give Ford GT40s, Lola T70s and other cars with American engines a new lease of life. Since these engines were developing about 400 bhp at the time, there was every prospect of interesting racing, with these cars competing against the 3-litre prototypes. But lamenting the fact that Ford was unwilling to develop a real racing version of the 289 engine, Len Bailey remarked to me at the time that one of the manufacturers, either Ferrari or Porsche, would surely take advantage of the regulations to build a batch of 25 sports-racers with new racing engines.

In the event, it was Porsche that found the considerable finance needed to develop a 5-litre sports-racer. The 917 was first shown at the Geneva Motor Show in March 1969, and Porsche lined up the 25 needed for homologation early that year. The car was really a logical development of the 908 3-litre car, and on paper at least seemed to be streets ahead of the opposition, who were relying on aged GT40s or 3-litre prototypes.

Because they did not expect anyone else to develop a 5-litre car, Porsche adopted a 4.5-litre flat-twelve engine, with the 86mm by 66mm bore of the 3-litre unit, and the decision speeded up development. Initially, the engine produced about 520 bhp at 8000 rpm, and it incorporated several novel features. With such an engine, the crankshaft is very long, and car is needed to avoid catastrophic torsional vibrations. To avoid these problems, two connecting rods were mounted on each crankpin, which makes the crankshaft as short as practicable, and the drive to the clutch was taken from the middle to the crankshaft, In fact, this simplified manufacture as well since, in effect, there are two six-cylinder crankshafts joined together by the take-off gear. The drive for the four camshafts was also taken from the middle of the crankshaft. Other novelties included the use of titanium connecting rods, and the use of chrome-plated aluminium cylinder barrels. As might be expected, many magnesium components, including the crankcase, were used. Initially, a Fichtel and Sachs clutch was installed in conjunction with the Porsche five-speed gearbox. Both the chassis and suspension followed existing Porsche practice, but the frame was unusual by normal standards in that it consisted of an aluminium spaceframe – as did the 908.

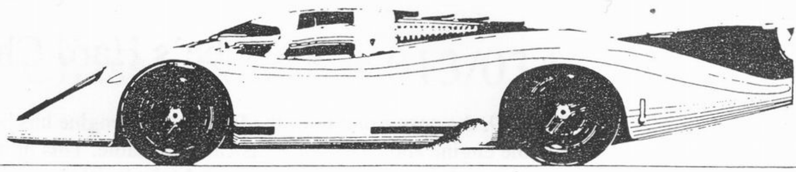
Low-drag body

But when the car first appeared, it was the body that stole the show. It had a fairly short nose, a narrow and long cockpit or "glasshouse", and a long tail. At the rear of the tail were a pair of moveable flaps, and these were actuated by a linkage connected to the rear suspension. These were designed to keep the car riding at a constant angle, so if the rear of the car lifted the flaps moved upwards to increase downthrust. (Mobile flaps were all the rage at the time, but were banned during 1969, and after Le Mans the flaps of the 917 were fixed.)

Few racing cars meet with success immediately, and even fewer sports-racing cars. Because the main sports car races are of six to 24 hours duration, reliability is all important, and this usually results mainly from race experience. So it was not to be expected that the 917 would sweep all before it in 1969. In the early races, the car gained a reputation for poor handling, and it was clear that Porsche had not really come to grips with the aerodynamic problems, despite the fact that long and short tails were produced. Porsche cars have always had a reputation for low drag, and it seemed likely that Porsche were unwilling to sacrifice the low drag for downthrust and stability at first.

At Le Mans, however, the opposition in the form of Ferrari, Gulf-Mirage and Alfa Romeo saw what they could expect. With the engine now developing 580 bhp at 8400 rpm, the 917 reached 236 mph on the Mulsanne Straight and led for 20 hours before retiring. At the same time, however, John Woolfe's fatal accident on the first lap increased the suspicion that all was not well with the handling.

PORSCHE'S HARD CHARGER



Enter Gulf and JW

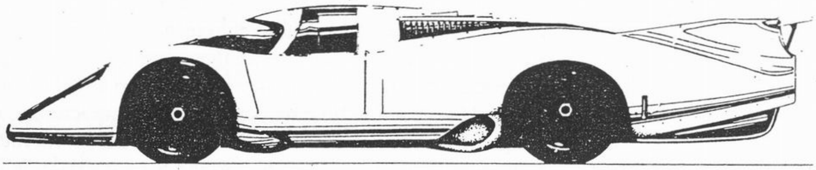
For 1970, operation of the 917s was entrusted to John Wyer's JW Automotive and Porsche-Salzburg, both of whom received full support from the factory. Evidently, the experience of Wyer and Horsman led to JW Automotive, who were sponsored by Gulf, making significant improvements to the 917s. The most marked change was the adoption of a wedge-shape short tail, which improved both the stability and the handling, even if it did increase drag. A Borg & Beck triple-plate clutch was adopted, as were Girling calipers (on the Gulf cars only, owing to licensing arrangements) and perforated discs. For all races except Le Mans, a four-speed gearbox was used.

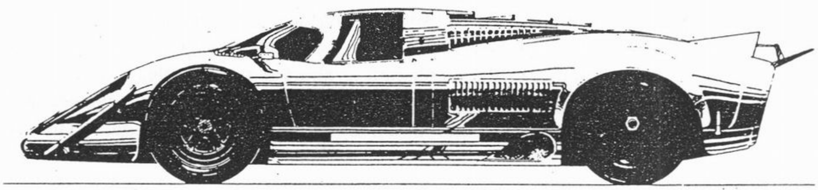
As if that wasn't enough, by the Monza 1000Kms race some cars appeared with 4.9-litre engines! These were almost the same as the 4.5-litre units, except that the stroke had been increased from 66 to 70.4mm, and the power output was raised to 600bhp at 8400rpm. Maximum torque was 415lbs/ft at 6400rpm.

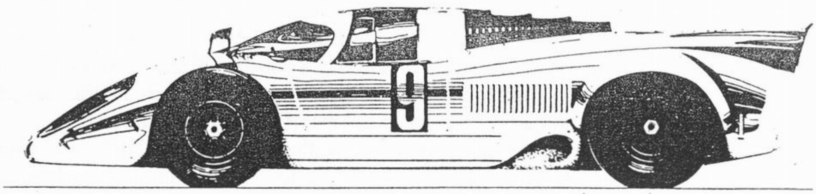
Already, 917s had won at Daytona and Brands Hatch, and one of the 4.5-litre cars won at Monza. Now, they really took over, winning at Spa, Le Mans, Watkins Glen and the Osterreichring. Porsche's dedication to reducing drag dominated the factory development that year, and evidently two cars were destroyed while a satisfactory solution eluded the engineers. However, a successful long tail was produced for Le Mans, but John Wyer preferred his short-tail cars, which had extra rear wings. In fact, it was one of the short-tailed Porsche-Salzburg cars that won, driven by Herrmann and Attwood, while a long-tailed car was second.

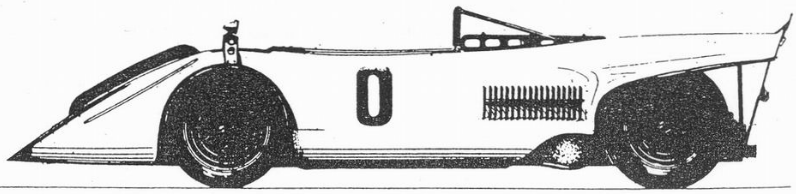
Prototypes again

Once again the regulations were changed for 1971, perhaps with the aim of giving someone other than Porsche a chance. So for that year only, 5-litre prototypes were admitted, but for 1972 a 3-litre class was to be the premier category, anything larger being banned. Therefore, Porsche set about improving the performance of the 917 on a









1969 917LH, 4.5 litre

1969 917LH, 4.5 litre

1969 917K, 4.5 litre

1969 917K, 4.5 litre

1969 917PA, 4.5 litre

PORSCHE'S HARD CHARGER

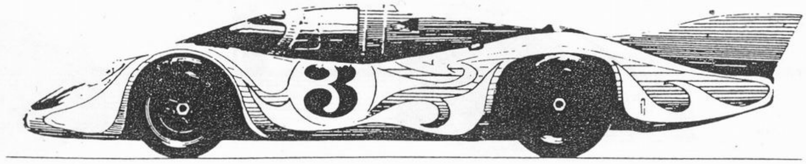
prototype basis for that year, and on a long-term basis for an onslaught on CanAm racing in North America.

As a first step, the engine was enlarged to 4998cc, by the use of a 86.8mm bore instead of the 86mm bore, in conjunction with the 70.4mm stroke of the 4.9litre engine. The cylinder bores were coated with Nikasil, a nickel-silicon material, and these changes improved the durability and allowed the power output to be increased to 630bhp. This increase still left the specific output of 126bhp/litre a little lower than that of the 4.5litre unit, and was expected to be barely enough to compete with the new Ferrari prototypes. At the same time, the gearbox was strengthened, and a lightweight body construction, consisting of a sandwich of thin epoxy resin skins and a foam core, was introduced.

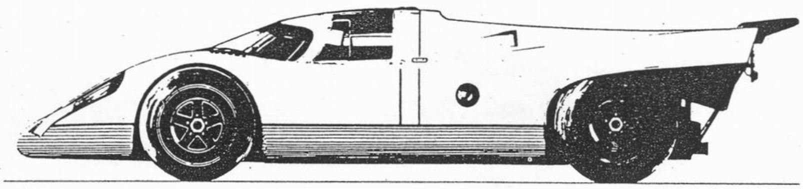
Although the Ferrari 512M was definitely faster than the Porsches at the beginning of 1971, its reliability was poor, so Ferrari decided to use the season to develop the 3-litre car for 1972. Therefore, the Porsche steamroller continued: the 917s won at Buenos Aires, Daytona, Sebring, Monza, Spa, Le Mans, the Osterreichring and Watkins Glen. Perhaps the greatest achievement was at Spa, where Pedro Rodriguez and Jack Oliver averaged 154.7mph. Jo Siffert, who drove with Derek Bell to finish second, was credited with a lap of 3mins 14.6secs – a speed of 162mph! And since Siffert and Rodriguez were circulating the two Gulf-Wyer cars in close company at the time, the record might just as easily stand to Rodriguez.

During 1971, several different body shapes were tried, but most incorporated a concave front deck and a flatter front undershield. The long tail was also revised successfully, and Oliver was timed at 240mph at Le Mans in a car fitted with a long tail. One of the curiosities of Le Mans was the Porsche Big Bertha, an attempt to gain the best from the short and long tail designs. This squat-looking car was developed by the Porsche experimental department and SERA, a French consultancy firm. Evidently, Porsche stylists were asked to paint the car, and they responded by painting it pink, and identifying the various sections as parts of the pig's anatomy! Whether this indicates their excellent sense of humour of profound disgust, I don't know; in any case, the car crashed.

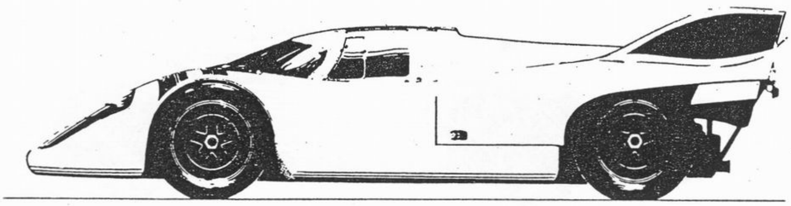
But 1971 saw the transition of the 917 from a long-distance racer to a CanAm car. First, Porsche developed a magnesium chassis



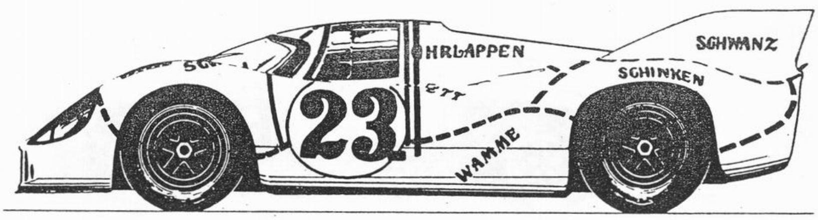
1970 917LH, 4.9 litre



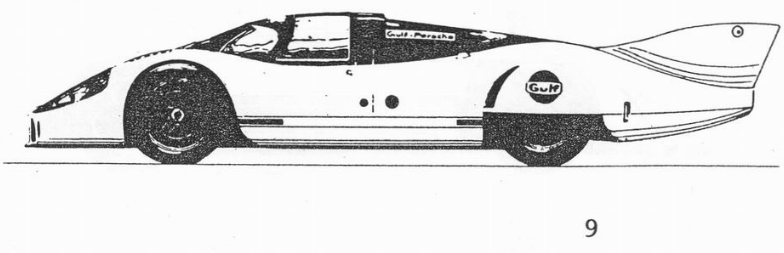
1971 917K, 4.9 litre



1971 917K, 4.9 litre



1971 917/20, 4.9 litre



1971 917LH, 4.9 litre

frame, in the search for low weight, and this was incorporated in the Le Mans winning car. Then, a 5-litre open car was built for the 1971 CanAm Series, and was driven with some success by Jo Siffert, who died at Brands Hatch later that year. In addition, a 5.4-litre engine was built, and this had 90mm bores. However, owing to the compromises involved in this design, Porsche started work on the real CanAm development, turbocharging with the smaller engines.

Turbocharging

It was decided to use twin Eberspacher turbochargers on the engine, and most of the development centred around the problem of reducing the lag before the engine responded to throttle opening. With a turbocharged engine, the turbine has to speed up before the engine responds to throttle opening, and it is here that Porsche made most improvements. About 20lbs boost was used, and a by-pass valve prevented this being exceeded. Turbocharged, the 5-litre engine developed about 850-900bhp...

To transmit this power, a new gearbox was designed, stronger titanium driveshafts were used, and Porsche developed their own aluminium brake calipers. One of the two Roger Penske cars had an aluminium frame, the other magnesium. The bodies were designed to produce the maximum amount of downthrust without much care being paid to low drag.

Within a few races, and despite Mark Donohue's serious accident, the 917 had revolutionized CanAm racing. It had shown that sheer power was enough to win, even if the handling and braking did not seem to compare with the McLarens, which struggled to keep up with only 700-750bhp.

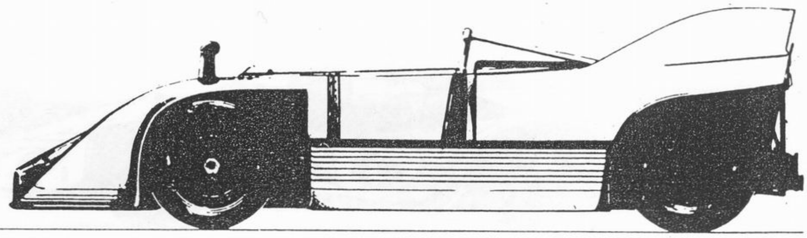
For 1973, the 917 was further modified, with a new body and the adoption of the 5.4-litre engine, developing well over 1000bhp. This year there are six turbocharged 917s, and the privately-owned McLarens are lucky if they can get within five seconds of the Porsches' lap times.

So from 1970 to 1973 the Porsche 917 has dominated each class of racing for which it has been entered seriously. The earliest cars achieved their dominance because Porsche were prepared to take advantage of the regulations, and were able to produce reliable cars, or enough cars so that some always kept going. In CanAm, Porsche were clever enough to exploit turbocharging, without suffering the problems of poor throttle response which dogged other attempts to gain high boost pressures.

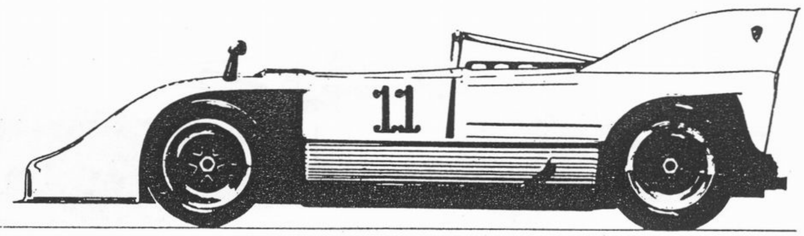
Development still continues, of course.

One of the latest developments is the instant power switch. This is an electrically controlled device that varies the boost pressure by operating the relief valve in the turbocharger ducting; if the driver feels the opposition is getting too close, he can increase the boost temporarily and gain more power!

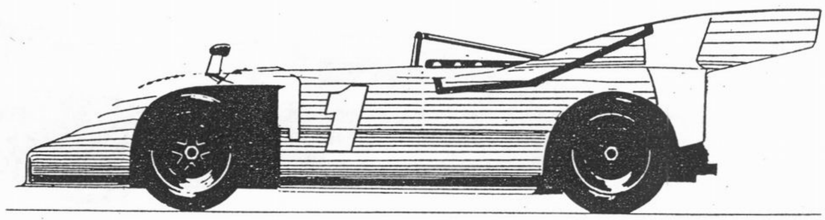
And that really illustrates how far the 917 is ahead; at the flick of a switch it can get further ahead, and the opposition is still trying to make turbochargers work!



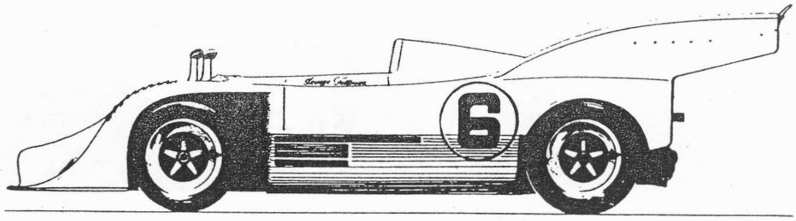
1971 917/10, 5.0 litre



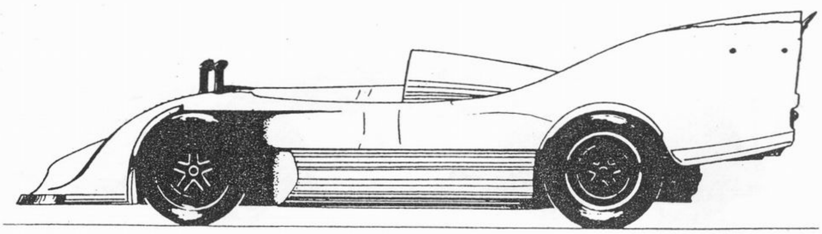
1972 917/10, 4.5 litre



1972 917/10, 4.5 litre



1972 917/10K, 5.0 litre, turbo



1972 917/10, 5.0 litre, turbo

TRANSMISSION
Casing material Magnesium.

Clutch 3-disc, dry.

Gearbox Fully Porsche-synchronized 4- or 5-speed gearbox with individually interchangeable gears. Same casing used with 4 or 5 speeds, except for 1972 type 917/10 which had reinforced box taking 4 speeds (and reverse) only.

Differential (1969–71) Disc-type limited slip. Up to 75% slip limitation.

Drive shafts Titanium. Incorporating a sliding joint, two universal joints and a cushioning 'Giubo' rubber joint ('dough-nut'). No sliding joint in 1972 917/10.

FUEL TANKS
Carried by frame, below door sills. Two tanks with a total capacity of 31 Imp. gallons in 1969. One flexible safety bag-tank of 26.5 Imp. gallons capacity on 917 coupés 1970–1. Two safety bag tanks of 42 gall capacity on 1969 917 PA Spyder. Two safety bag tanks of 66 Imp. gall total capacity on 917/10 Spyders.

BODY
Fibreglass bonded to chassis. Two seats, two doors. Moulded epoxy material on some 1971 coupés and all 917/10 Spyders.

INDIVIDUAL SPECIFICATIONS ACCORDING TO YEAR AND TYPE

ENGINE
4.5-litre (first used Spa 1000 Km race, May 1969). Used on works-sponsored cars 1969-1970.

Bore x Stroke 86 x 66 mm.
Capacity 4494 cc.
Compression ratio 10.5 to 1.
Net Power output 580 hp at 8400 rpm.
Max torque 52 mkg (376 lbs/ft) at 6600 rpm.
Weight 528 lbs.
Cromal cylinders.

4.9-litre (first used Monza 1000 Km race, April 1970). Used on works-sponsored cars 1970–71.

Bore x Stroke 86 x 70.4 mm.
Capacity 4907 cc.
Net power output 600 hp at 8400 rpm.
Max torque 57.2 mkg (415 lbs/ft) at 6400 rpm. Otherwise as above.

5-litre (first used Brands Hatch 1000 Km Race, April 1971). Used on works-sponsored cars in 1971.

Bore x Stroke 86.8 x 70.4 mm.
Capacity 4998 cc.
Net power output 630 hp at 8300 rpm.
Max torque 58.5 mkg (425 lbs/ft) at 6400 rpm.
Nikasil cylinders.
Otherwise as above.

5.4-litre (first used 1972 for privately-owned Group 7 cars 917/10 on 17).

Bore x Stroke 90 x 70.4 mm.
Capacity 5374 cc.
Net output 660 hp at 8300 rpm.
Max torque 63 mkg (456 lbs/ft) at 6400 rpm.
Nikasil cylinders.
Otherwise as above.

4.5-litre turbo-charged (first used 1972 for privately-owned Group 7 cars 917/10 only).

Bore x Stroke 85 x 66 mm.
Capacity 4494 cc.
2 Ebersprächer exhaust-gas driven turbo-chargers.
Net power output 850 hp at 8000 rpm.
Max torque 85 mkg (615 lbs/ft) at 6600 rpm.
Boost pressure (max) 20 lbs/sq in.
Weight 600 lbs.
Nikasil cylinders.

5-litre turbo-charged (first used Mosport Can-Am race, June 1972 in magnesium frame 917/10 works-sponsored car).

Bore x Stroke 86.8 x 70.4 mm.
Capacity 4998 cc.
Net power output approx. 950 hp at 8000 rpm.
Max torque approx 95 mkg (690 lbs/ft) at 6400 rpm.
Otherwise as 4.5-litre turbo-charged.

CHASSIS
Brakes 1969 Ate aluminium calipers. 1970 Girling aluminium calipers on cars run by JW Racing Team, Ate on cars run by Porsche-Salzburg. 1971 Girling calipers on most factory sponsored cars (JW and Martini). Perforated ventilated discs used on most occasions in 1970-71. Standard on 917/10 Spyder. Chrome plated copper alloy discs on aluminium vanes used experimentally in Daytona 24 Hours 1970, on rear brakes only. Porsche-designed aluminium caliper with titanium bolts standard on 1972 917/10 Spyder.

WHEELS

Rim width front:	1969:	9 in (917 PA Spyder 10.5 in).
	1970–71:	10.5 or 12 in.
	1972:	12 in (10.5 for rain tyres).
Rim width rear:	1969:	12 in (end of season 15 in) (917 PA 15 or 17 in)
	1970–71:	15 or 17 in.
	1972:	17 in. (15 in for rain tyres)

DIMENSIONS

Wheelbase 2.30 m (90 in) all models, except 1972 series 917/10 which have 2.316 m (90 ⅝ in)
Track, all 917 coupés (depending on rim width used);:

1969:	front	1.488 m (58.8 in)
	rear	1.457 m (57.5 in) with 12 in rims
		1.533 m (60.4 in) with 15 in rims
1970–71:	front	1.526 m (60.2 in) with 10.5 in rims
		1.564 m (61.7 in) with 12 in rims
	rear	1.533 m (60.4 in) with 15 in rims
		1.584 m (62.7 in) with 17 in rims

1969 917 PA Spyder: as 917 coupé on 10.5 in front and 15 or 17 in rear rims.
1971–72: 917/10 Spyder:
front 1.620 m (64 in) with 12 in rims.
rear 1.586 m (62.7 in) with 17 in rims.

TRANSMISSION
Clutch Fichtel and Sachs in 1969, Borg and Beck thereafter.
Weight All coupés were only just above the 800 Kg (1763 lbs) minimum weight required by CSI for Group 5 cars of the 5-litre class. Even long-tail 1971 Le Mans cars with full supplementary night equipment and two batteries were only 25 kg (55 lbs) above limit. Magnesium car was under the limit and had to have 12 gallon oil tank part-filled to comply. John Wyer-prepared cars were usually 25-30 kg (55-66 lbs) heavier than cars prepared at factory.
1969 917 PA Spyder: 750 Kg (1653 lbs).
917/10 Spyder, unsupercharged: approx 734 Kg (1618 lbs)
917/10 Spyder, turbo-charged:
750 Kg (1653 lbs) with aluminium frame. 735 Kg (1620 lbs) with magnesium frame.

THE PORSCHE 917 RACING RECORD IN EVENTS COUNTING TOWARDS THE WORLD CHAMPIONSHIP OF MAKES

1969			
Aug. 10 Austrian 1,000 Kms., Osterreichring			
1st	J. Siffert/K. Ahrens	917 K–4.5 litre	115.7 mph (186.3 kph)
3rd	R. Attwood/B. Redman	917 K–4.5 litre	
1970			
Feb. 1 Daytona 24 hours, Florida			
1st	P. Rodriguez/L. Kinnunen	917 K–4.5 litre	114.8 mph (184.8 kph)
2nd	J. Siffert/B. Redman	917 K–4.5 litre	
Mar. 22 Sebring 12 hours, Florida			
4th	P. Rodriguez/L. Kinnunen	917 K–4.5 litre	
Apr. 12 BOAC 1,000 Kms Brands Hatch			
1st	P. Rodriguez/L. Kinnunen	917 K–4.5 litre	92.1 mph (148.3 kph)
2nd	V. Elford/D. Hulme	917 K–4.5 litre	
3rd	R. Attwood/H. Herrmann	917 K–4.5 litre	
Apr. 25 Monza 1,000 Kms., Italy			
1st	P. Rodriguez/L. Kinnunen	917 K–4.5 litre	144.5 mph (232.6 kph)

917 K = Short-tail car   917 L = Long-tail car

Porsche 917

First race for the Porsche 917 was on 11th May 1969 at Spa where Gerhard Mitter drove "No. 30".

The Porsche 917 had an unusual gear shift pattern. The fifth gear was outside the H pattern of gears and drivers were always worried about changing from fourth gear to third gear instead of fourth gear to fifth gear as intended; and at high speeds a broken engine could result.

At Le Mans in 1969, Vic Elford with Dick Attwood set a new lap record of 145.41 mph but retired four hours before the finish.

On the 10th August 1969 two Porsche 917's were crewed by Siffert/Ahrens and Redman/Attwood. The car of Jo Siffert and Kurt Ahrens won the race while the car of Redman and Attwood was placed third.

David Piper later acquired the Austrian Grand Prix winning car which had chassis number 917-010. His car was the only one to go to Buenos Aires for a non-championship race on 11th January 1970 but had to retire.

Cracked bell housings had troubled the Porsche 917 and for 1970 a new design was made. Transmission housings were strengthened to fit in with the improved 912 engine.

The Porsche 917 started with a 4.5 litre engine but a 4.9 litre version also became available.

Three cars were prepared for the 1970 Daytona and the race cars were the Porsche 917-015 of Rodriguez and Kinnunen. The spare car was chassis number 917-013. A Porsche 917K (chassis number 917-011) was entered for Elford and Ahrens.

The 1970 SERA-designed Porsche 917L was over two inches wider than the Porsche 917K. The Porsche 917L was also over two feet longer than the Porsche 917K.

The K-bodied Porsche 917 gave Hermann and Attwood a victory at Le Mans in 1970.

On the 12th July 1970 at the Can-Am race the Porsche 917 came in 2nd place for Siffert and 3rd place for Attwood. Other Porsche 917Ks were 4th, 6th and 7th.

Also with a Porsche 917K Van Lennep was placed second at the 1970 Interserie, Interserie Porsche 917s not having to conform to Group 5 regulations.

At Brands Hatch on 4th April 1971 a Martini Porsche 917K came 9th.

On 9th May 1971 at the Spa 1000km Bell and Siffert drove Porsche 917 chassis number 917-014 while Rodriguez and Oliver drove the Porsche 917 with chassis number 917-015.

Porsche 917

917 origins

PHILOSOPHICALLY, the ancestry of the Porsche 917's design goes right back to the original rear-engined Porsches of the late 1940s, for the firm's chief, Dr "Ferry" Porsche, had been closely linked with each and every one of them. However, while all had had air-cooled engines, some had used the "classic" VW-derived rear-engine layout, and a few of the more special ones had used the more modern mid-engined layout. There had been open Spyders, and closed coupés, sometimes on the same mechanical base.

The first racing Porsches with large-tube frames had raced in the 1950s, but the first Porsche to have a small-diameter multi-tube space frame was the 1962 Grand Prix single-seater. The first two-seater with a multi-tube frame was a 1965 hill-climb car, and a refined version was standardised on the Carrera 6 (later called the 906) model announced late in 1965. The 907 followed the 906, the 908 replaced that, and the 917 was really designed around a modified version of the 908's chassis and suspensions.

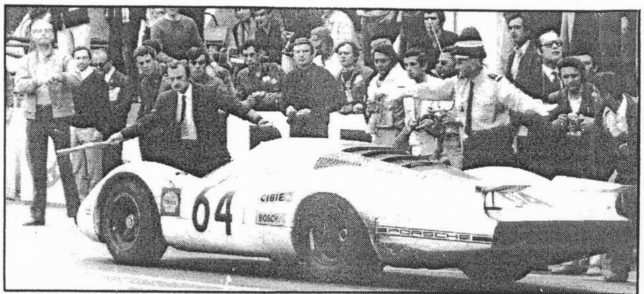
The 917 was the first-ever Porsche to use a flat-12 cylinder engine, but even so it had strong links with the last. All Porsches used flat-4 engines until the 1960s, when two new engines, the 911 (road car) flat-6 and the 1½-litre Grand Prix flat-8 were revealed. The Grand Prix unit was eventually enlarged to 2.2-litres, but that was the end of that particular line of development.

The Type 908 used a 3-litre flat-8 engine which was almost entirely new, though it used a few Type 906 racing-engine components. The 917's flat-12 engine, however, was effectively one-and-a-half 908 engines, for it used the same reciprocating parts, bore and stroke, valves and port dimensions.

The gearbox cluster was new for the Type 917. □

Objectives

LATE IN 1967, motor sport's governing body, then the CSI, made two decisions affecting the shape of the Manufacturer's World Championship for sports car racing in 1968. They put a limit of 3-litres on prototypes, but they also put a limit of 5-litres on "production" cars which had been built in at least a run of 25 identical units within 12 calendar months. Porsche had already decided to build a 3.0-litre car (the Type 908) for 1968, even before this ruling was made, and used those cars throughout the season.



Starting point for 917 design – long-tailed 3-litre 908 that so-nearly won Le Mans in 1969

The objective behind the design of the Type 917, therefore, was to build what was effectively a new prototype, but to build no fewer than 25 cars all at once, so that it could instantly be an homologated model in the 5-litre class. In that the category was otherwise attended by obsolete cars like the Ford GT40 and the Lola T70, it was meant to give Porsche an immediate, and colossal, advantage over all rivals.

The 917 was to be a car capable of winning the World (Sports Car) Championship for Porsche, but one which would not over-stretch their (admittedly formidable) engineering and development resources. Its chassis frame, therefore, was to be a modified derivative of the 908 design, as was the suspension and the body shape, while the flat-12 engine was effectively little more than an extended flat-8, Type 308, engine. The engine design, indeed, showed evidence of this short-cut in its original capacity of 4.5-litres, whereas the class limit was 5.0-litres.

Because 25 cars simply had to be made (and seen to be made) for it to be homologated, the design had, at least, to be reproducable, but Porsche did not let this compromise the detail of their design. Instead, they merely threw every possible effort behind construction, knowing that their own works, or works-blessed, teams, would use up the majority of the 25 cars. □

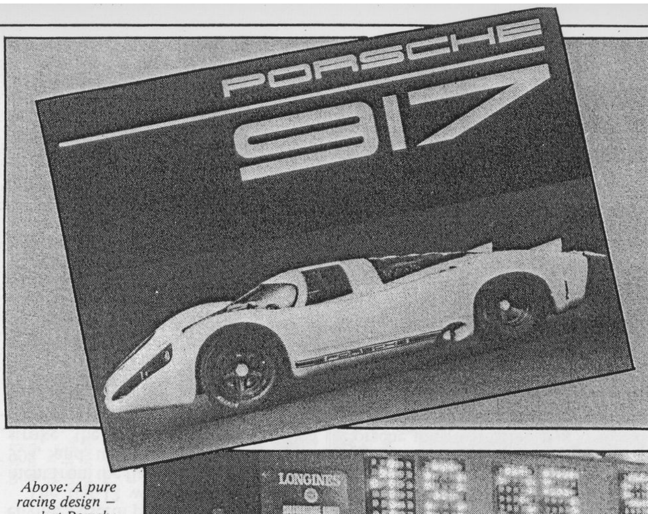
The Design

EXCEPT THAT it was designed in something of a hurry, and was developed from the bare bones of an existing Porsche racing car model, the Porsche 917 was one of the most "pure" designs ever conceived. Quite simply, it was a technical and practical *tour de force* by Porsche's engineers, who did not let the fact that 25 identical examples had to be constructed, deter them at all.

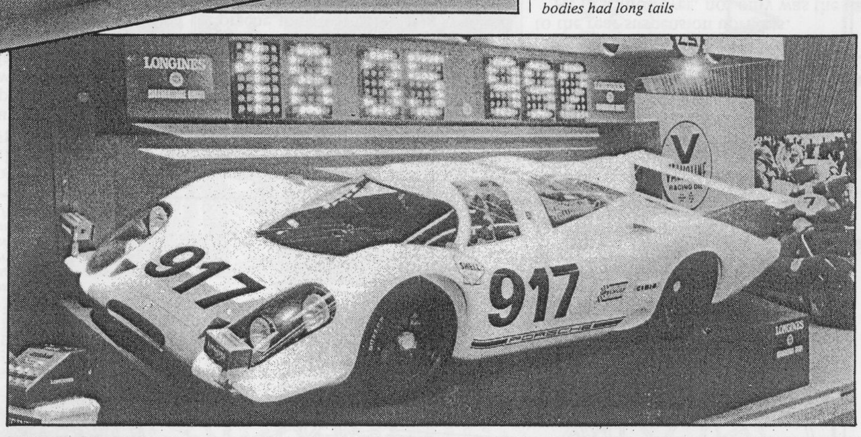
To save time, to cut down on development expense, and to eliminate, as far as possible, the teething troubles inevitable in a brand new design, the basic engineering of the 917 was based fairly closely on that of the 3-litre 908. Design of the Type 917 began in July 1968 (four months after the 908 had made its first appearance (and caused a sensation) at the Geneva Motor Show of March 1969, and 25 identical examples were paraded for homologation inspection in April 1969. The 917's first race was at Spa in May, when the engine blew up on the first lap. The first race win was in Austria, in August, just 13 months after the design had begun.

Basis of the design was an aluminium multi-tubular space frame, and a mid-mounted flat-12 4.5-litre air-cooled engine, both developed from the 908's equivalent items. That is the story, simply told, but it was much more involved in detail.

The first-ever space-frame two-seater sports car was a 1965 hill-climb car, and the Carrera 6 (later known as the 906) went on sale at the end of the year with the same type of frame. From the six-cylinder 906 came the 2.2-litre eight-cylinder 907 of 1967, and in 1968 this gave birth to the new 908. The 908's frame, therefore, was a lineal descendant from that of the 906, but different in many details. The new 917's frame was basically that of the 908, still on a 7ft 6in (90in) wheelbase, but with the cockpit moved forward to



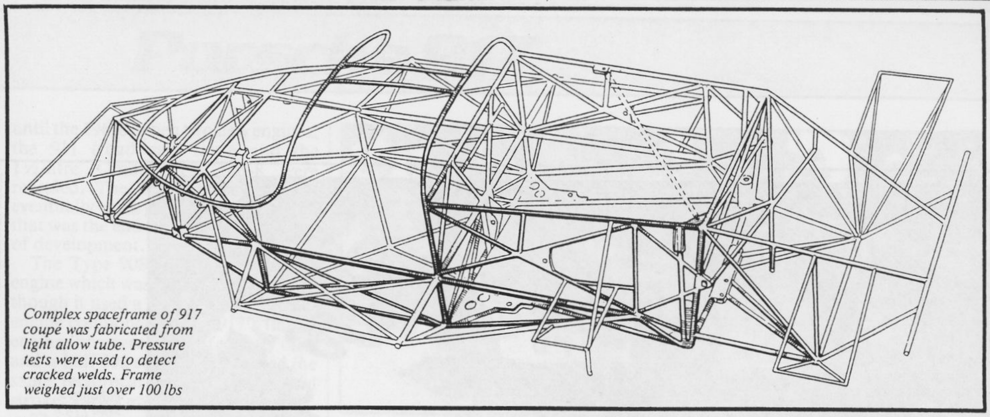
Above: A pure racing design – but Porsche followed the "production" rules to the letter. They even produced a 917 sales catalogue



Below: Public debut – the 917 caused a sensation when it appeared at the 1969 Geneva Motor Show. All the 25 "homologation" bodies had long tails make space for the more bulky engine of the 917, and it weighed just over 100lb. The seating was so far forward that the pedals were actually ahead of the line of the front wheels, and the "spacesaver" spare wheel was above and behind the transmission in the tail of the car. To check for weld failures during assembly (or after a race), the chassis was fitted with a tyre valve at one point, and could be literally pumped up to see if pressure was sustained!

Front and rear suspension was very like that of the 908, with a great deal of titanium and magnesium featuring in the components to cut weight to a minimum. Front suspension was by double wishbones, rear suspension by transverse links and twin trailing radius arms, while combined coil spring/damper units and anti-roll bars were specified at front and rear. Wide rim (rim widths increased as the years passed, and could be varied according to tyres, circuits, and driver preferences) wheels were cast-alloy units with centre lock fixings, and vast ventilated disc brakes (originally by ATE, but later by Girling) were mounted outboard, at the hubs.

The engine was a simply massive (but surprisingly light – 528lb, including all accessories) air-cooled flat-12, featuring a two-piece crankshaft and central power take off by gear to an output shaft running under the line of the crankshaft to the transaxle, along with two valves per cylinder and two overhead camshafts to each bank of cylinders. The cooling



Complex spaceframe of 917 coupé was fabricated from light allow tube. Pressure tests were used to detect cracked welds. Frame weighed just over 100 lbs

fan was horizontally mounted above the cylinder banks, and was stated to absorb only 17bhp at peak engine speeds – less than three per cent of the engine's useful power output.

The flat-12 was a direct development from the flat-8 engine used in the 908, and used the same bore and stroke, the same valves, port sizes, reciprocating parts, camshaft profiles, and many other details. With a bore and stroke of 85×66mm, the 908's capacity had been 2,996cc, right up to the 3-litre prototype limit so, as increased to 12 cylinders, the 917's initial capacity was 4,494cc, half a litre under the 5-litre limit. However, since the very first engine produced 542bhp, and the first engine installed in a car produced 580bhp, a lack of power was never likely, especially as the torque of that splendid race engine was 376lb ft at 6,600rpm. There *was* more capacity to come, and this would be developed at a later date.

To deal with such a hulking engine, a new transaxle was needed. Like other recent designs, this was a Porsche unit, with five synchronised forward speeds, and a ZF limited-slip differential. It was thought likely that the engine would be so flexible that in some cases only four speeds would be necessary, and this, in fact, transpired. Later, as the power went up and up, it was necessary to provide only four, stronger, forward gears.

The mechanical components provided the sensation, but the body styles caused the controversy. Right from the start, the 917 was designed as a closed coupé, with two conventionally hinged doors cut deeply into the roof panel, and short and long tails were to have been provided. To aid stability on fast circuits like Le Mans, the long tail featured movable trim tabs on rear fins, the tabs being linked to the rear suspension uprights.

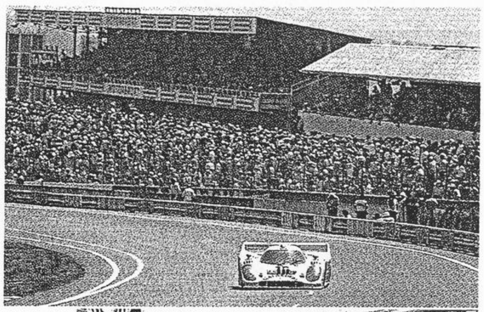
At first, however, not only was the car's high speed stability suspect, partly due to faulty aerodynamics, and partly due to flexing of the body structure, but the movable flap ran into trouble from the law-enforcers and scrutineers. In the next three years, more time and effort would be spent on aerodynamic development (which was necessary) than on power improvement (which was not).

SLEEP of FAITH

PORSCHE'S 917 IS ONE OF THE GREATEST CARS EVER. BUT THAT'S NO REASON, SAYS GARY WATKINS, TO BUILD A NEW ONE AND RACE IT AT LE MANS A DECADE AFTER THE ORIGINAL HAD BEEN PENSIONED OFF

IMAGINE COMING UP WITH THE BRIGHT idea of building a replica of Mazda's 1991 Le Mans winner for the 24 Hours – this year. Could you imagine the reaction if you rang Japan asking for the original chassis drawings and a supply of engines? Do you then think you'd be able to persuade one of today's top sportscar drivers to race the thing?

It may sound absurd, but 20 years ago someone had a similar idea. What's more, they pulled it off, despite choosing to copy one of the all-time great racing cars. Nearly 10 years after being outlawed from world championship sportscar racing, Porsche's 917 went back to Le Mans as a Group 6 car.



Only the Kremer brothers from Cologne could ever have come up with such a preposterous idea. And only Erwin and Manfred – long-time Porsche racers, builders and restorers – could have turned such an outlandish dream into reality. They got plans for the chassis out of Weissach, had a couple of five-litre flat-12s built and even instigated a small production run of 917 gearboxes. And who did they get to drive it? None other than a former factory driver, Bob Wollek.

The idea to build a replica of the 917K coupe had been hatched in the late 1970s as an adjunct to Kremer Racing's restoration business.

"Over a period of about two years we collected so many 917 parts that we started thinking about building a car," recalls Erwin. "At that time we weren't thinking of racing it, except perhaps in historic events."

At the same time, the company had in its workshops a British-owned 917 spyder being converted back to its original closed-top form. That provided a template for the car, but Kremer still required some chassis drawings, which Porsche was only too happy to provide.

Veteran Weissach engineer Norbert Singer remembers supplying information on suspension pick-ups and the like. "We didn't give them the complete plans," he says, "but we were happy to help because we thought they were building a show car that would have no race history."

Manfred Janke, Porsche's sports boss at the time, claims no support would have been forthcoming had the Stuttgart marque had any inkling that the car would end up competing at Le Mans. Drivetrain components would not have been too problematical, however. "Selling engines and gearboxes was part of business," he says. "They were always available."

Exactly when the Kremers decided to race the car isn't clear. Erwin insists that it wasn't until early 1981. He claims the plan to take the car to that year's Le Mans was fired by the organisers of the race, the Automobile Club de l'Ouest.

"They came to see me, saw the car and said, 'Why not bring it to the 24 Hours?'," he remembers. "Alain Bertaut [the ACO's long-serving rules boss] said it would make a great story to have a modern version of the 917 back at Le Mans. The car was only 60-70 percent finished at this point. I knew I would have to make many changes to the body, the suspension and even the chassis."

Kremer strengthened the aluminium spaceframe, modified the suspension and, most significantly, altered the aerodynamics of this short tail or *kurzheck* car. The Kremer chassis retained the look of a 917K, albeit more slabsided, but little original bodywork was retained bar the cockpit section. "Apart from the windscreen and doors, everything was custom-made," explains Achim Stroth, team manager at Kremer for a quarter of a century. "We were trying to bring the concept up to date, but we never went into a wind tunnel."

The short time available for the build process wasn't the only problem faced by Kremer Racing if it was to make June's Le Mans, the last time large-capacity Group 6 cars would be eligible. The money also had be found to fund the assault. The first port of call was the

Left: The Kremer team worked hard in qualifying, but not even Wollek could get it higher than the ninth row. Top: The 1981 crowd had never expected to see a 917 pounding round Le Mans in anger. Neither did Porsche. Above: Malardeau's support had strings attached – two journeymen racers with the francs

German drinks company that adorned the side of its 935 K3s in the domestic DRM Group 5 series. "I had a picture taken of myself and Bob holding up the chassis with Manfred inside holding a bottle of Jaegermeister," says Erwin. "Unfortunately they weren't interested."

Coverage of the project in France attracted the interest of Toulouse property company Malardeau. It provided the lion's share of the budget along with BP France, but there was a drawback: French amateur drivers Xavier Lapeyre and Guy Chasseuil came with the money.

The Kremer replica – now designated 917K-81 – made it to Le Mans but with less then 50 miles of testing under its belt after the briefest of shakedowns at the Nürburgring. This lack of testing cost the team dear when they arrived in France.

"Part of our problem was that the two drivers of, let's say, medium talent, needed a lot of track time in that kind of machine," explains Stroth. "I'm sure that if we could have kept Bob in the cockpit we would have sorted it out."

Even Wollek was a country mile off the pace in the opening qualifying sessions thanks to the wrong ratios in the car's four-speed CanAm-spec gearbox.

"Because time had been so short we didn't have the right ratios," says Erwin, "but Porsche came and gave us the right ones. They'd been against us racing the car initially, but now they wanted to help."

Wollek, a Kremer regular in the DRM, had encouraged the brothers in their unusual project, but his enthusiasm for the 917 replica waned over the course of the meeting. "The car wasn't bad," he said shortly before his death in March. "The new body gave more downforce at the front, but that big wing on the back blew the 917's number one advantage, namely its straight-line speed. It was desperately slow down the Mulsanne."

The Frenchman qualified on the ninth row, a full 15sec from Jacky Ickx's pole time in the latest incarnation of Porsche's 936. Wollek made little progress in the early stages of the race and abruptly threw in the towel at about eight o'clock on the Saturday evening. He was clearly affected by two serious accidents, one of which claimed the life of French Rondeau driver Jean-Pierre Lafosse.

"I asked myself what I was doing driving this shitbox with a couple of slower team-mates. I knew we didn't have a chance of a decent result," said Wollek, who complained that the car was nervous on the long straight. "I really had a bad feeling about that race, so I just walked away."

The fortunes of the 917K-81 took a further turn for the worse when Lapeyre collided with a Joest 935 and bent the chassis. Chasseuil managed only a handful of laps before engine failure put the car out of the race before one-third distance.

The reason for that failure isn't clear. Erwin Kremer insists the problem was caused by a bolt shearing on the exhaust manifold, putting the engine onto 11 cylinders. Stroth recalls the cause as an oil leak and a bizarre ACO rule that only allowed topping up at set intervals. Contemporary reports in the British press suggest crankshaft failure.

The Kremers had initially stated that the 917K-81 would race only at Le Mans, but they wheeled the car out at the last race for which it would be eligible, September's Brands Hatch 1000Kms.

I knew the car had retired from Le Mans for a silly reason, and I was sure I had made a good car," says Erwin. "I wanted to show that."

Wollek was paired up with Henri Pescarolo, who was in a unique position to compare the replica with the original. "Kremer did an interesting job on that car," says the four-time Le Mans-winner. "They had changed a lot from the old one and it was really nice to drive, and fantastic in the wet."

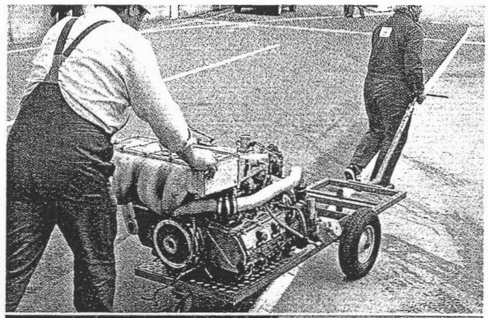
Wollek ended up third on the grid. Then, for the first half-hour of the race, the Brands crowd was treated to the sight of the past of sportscar racing battling for the lead with its supposed future – a Porsche 917 against Ford's brand-new C100.

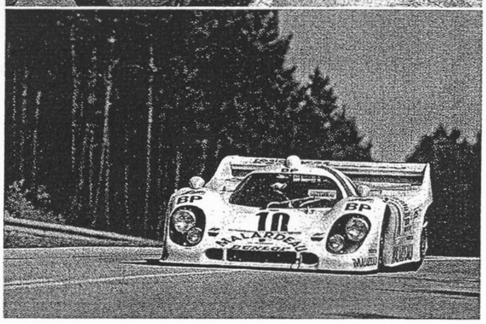
The latter was out of the race by the time Wollek took the lead in the second hour, but the glory lasted only a handful of laps. The Frenchman went off and tapped the barriers at Dingle Dell. The car looked undamaged, but its driver was unable to continue due to a broken steering linkage. Whether this was the cause or the effect of the accident depends on whether you believe Erwin or Wollek's story.

The 917's unlikely comeback was over after a fleeting moment of glory. Could there have been more had the Kremers got the car up and running earlier in the year? Wollek probably provided the answer at Brands when he suggested that Manfred Winkelhock's pole time in the Ford was a couple of seconds off a decent time. But don't forget Porsche's Le Mans-winning 936-81, itself an ageing design, was absent that weekend.

Singer believes the replica didn't have a hope of being competitive: "It looked nice, but it wasn't very efficient. Everything had moved on. Even our 936 was a lot lighter and stiffer."

After Brands, the 917K-81 was wheeled into the Kremers' private museum and then sold to another collector years later. The car may not have been successful at Le Mans, but its presence there must have greatly increased its value. Maybe that's what the Kremers had in mind all along.





'The new body gave more downforce at the front, but that big wing blew the 917's main advantage – it was desperately slow down the Mulsanne'

***Top:** The flat-12 engine had problems towing the new, large rear wing down the straights, especially allied to a four-speed Can Am-spec gearbox.*
***Above:** By the time Kremer's 917 retired, Wollek had thrown in the towel, and so its fortunes lay in the hands of Chasseuil and Lapeyre. It was a struggle*

Porsche 917 and its Racing Record

Date	Race and Venue	Driver(s)		
1969	Nurburgring 1000km	F.Gardner/D.Piper		8th place
1969	Austrian Grand Prix	J.Siffert/K.Ahrens		1st place
1969	Austrian Grand Prix	R.Attwood/B.Redman		3rd place
1970	Daytona 24 Hours	P.Rodriguez/L.Kinnunen		1st place
1970	Daytona 24 hours	J.Siffert/B.Redman		2nd place
21 March 1970	Sebring 12 Hours	P.Rodriguez/J.Siffert/L.Kinnunen		4th place
12 April 1970	BOAC 1000km	J.Siffert/B.Redman		20th place
25 April 1970	Monza 1000km	P.Rodriguez/L.Kinnunen		1st place
25 April 1970	Monza 1000km	J.Neuhaus/H.Kelleners		10th place
25 April 1970	Monza 1000km	G.van Lennep/H.Laine		11th place
25 April 1970	Monza 1000km	J.Siffert/B.Redman		12th place
17 May 1970	Spa 1000km	J.Siffert/B.Redman		1st place
17 May 1970	Spa 1000km	V.Elford/K.Ahrens		3rd place
17 May 1970	Spa 1000km	G.van Lennep/H.Laine		5th place
17 May 1970	Spa 1000km	R.Attwood/H.Herrmann		6th place
17 May 1970	Spa 1000km	H.Kelleners/J.Neuhaus		17th place
13-14 June 1970	Le Mans 24 Hours	G.Larrousse/W.Kauhsen		2nd place
11 July 1970	Watkins Glen 6 Hours	P.Rodriguez/L.Kinnunen		1st place
11 July 1970	Watkins Glen 6 Hours	J.Siffert/B.Redman		2nd place
11 July 1970	Watkins Glen 6 Hours	V.Elford/D.Hulme		4th place
11 July 1970	Watkins Glen 6 Hours	R.Attwood/K.Ahrens		6th place
11 July 1970	Watkins Glen 6 Hours	G.Larrousse/G.van Lennep		9th place
11 October 1970	Osterreichring 1000km	J.Siffert/B.Redman		1st place
11 October 1970	Osterreichring 1000km	V.Elford/R.Attwood		4th place
10 January 1971	Buenos Aires 1000km	J.Siffert/D.Bell		1st place
10 January 1971	Buenos Aires 1000km	P.Rodriguez/J.Oliver		2nd place
10 January 1971	Buenos Aires 1000km	D.Martin/P.Brea		10th place
30-31 January 1971	Daytona 24 Hours	P.Rodriguez/J.Oliver		4th place
20 March 1971	Sebring 12 Hours	V.Elford/G.Larrousse		1st place
20 March 1971	Sebring 12 Hours	P.Rodriguez/J.Oliver		4th place
20 March 1971	Sebring 12 Hours	J.Siffert/D.Bell		5th place
2 April 1971	BOAC 1000km	J.Siffert/D.Bell		3rd place
2 April 1971	BOAC 1000km	R.Jost/W.Kauhsen		6th place
2 April 1971	BOAC 1000km	G.van Lennep/G.Larrousse		9th place
25 April 1971	Monza 1000km	P.Rodriguez/J.Oliver		1st place
25 April 1971	Monza 1000km	J.Siffert/D.Bell		2nd place
25 April 1971	Monza 1000km	R.Jost/W.Kauhsen		7th place
25 April 1971	Monza 1000km	D.Martin/G.Pillon		9th place
9 May 1971	Spa 1000km	P.Rodriguez/J.Oliver		1st place
9 May 1971	Spa 1000km	J.Siffert/D.Bell		2nd place
9 May 1971	Spa 1000km	R.Jost/W.Kauhsen		4th place
12-13 June 1971	Le Mans 24 Hours	H.Marko/G.van Lennep		1st place
12-13 June 1971	Le Mans 24 Hours	R.Attwood/H.Muller		2nd place
27 June 1971	Osterreichring 1000km	P.Rodriguez/R.Attwood		1st place
24 July 1971	Watkins Glen 6 Hours	J.Siffert/G.van Lennep		2nd place
24 July 1971	Watkins Glen 6 Hours	D.Bell/R.Attwood		3rd place
24 July 1971	Watkins Glen 6 Hours	T.Adamowicz/M.Cabral		10th place
3 April 1972	7th ADAC 300km races (Nurburgring)	Willi Kauhsen	2nd place	2h 13' 3.8"
3 April 1972	7th ADAC 300km races	Leo Kinnunen	4th place	2h 17' 41.2"
3 April 1972	7th ADAC 300km races	Jurgen Neuhaus	5th place	2h 19' 33.5"
3 April 1972	7th ADAC 300km races	Ernst Kraus	8th place	
1 May 1972	Giampiero Segafredo Cup (Imola, Italy)	Willi Kauhsen	1st place	1h 33' 2.12"
1 May 1972	Giampiero Segafredo Cup	Ernst Kraus	3rd place	
21 May 1972	Super Sports 200 (Silverstone, Great Britain)	Leo Kinnunen	1st place	1h 42' 44.0"
21 May 1972	Super Sports 200	Ernst Kraus	4th place	

Porsche 917 and its Racing Record

Date	Race and Venue	Driver(s)		
9 July 1972	Interserie Race (Osterreichring, Austria)	Willi Kauhsen	2nd place	59' 38.57"
16 July 1972	Interserie Race (Hockenheim, West Germany)	Leo Kinnunen	1st place	1h 44' 6.0"
16 July 1972	Interserie Race	Willi Kauhsen	2nd place	
1972	Norisring 200 miles (West Germany)	Leo Kinnunen	1st place	2h 6' 26.3"
1972	Norisring 200 miles	Willi Kauhsen	2nd place	2h 6' 49.4"
1972	Norisring 200 miles	Franz Pesch	4th place	
27 August 1972	Interserie Race (Keimola, Finland)	Leo Kinnunen	1st place	1h 34' 23.25"
27 August 1972	Interserie Race	Willi Kauhsen	2nd place	
27 August 1972	Interserie Race	Chris Craft	3rd place	
24 September 1972	Interserie Race (Nurburgring, West Germany)	Leo Kinnunen	1st place	1h 51' 10.8"
24 September 1972	Interserie Race	Chris Craft	6th place	
1 October 1972	Baden-Wurtemberg Prize (Hockenheim, West Germany)	Leo Kinnunen	1st place	1h 28' 47.8"
1 October 1972	Baden-Wurtemberg Prize	Willi Kauhsen	2nd place	
1 October 1972	Baden-Wurtemberg Prize	Chris Craft	3rd place	
1 October 1972	Baden-Wurtemberg Prize	Franz Pesch	7th place	
11 June 1972	Labatt's Blue Trophy (Mosport Park, Canada)	Mark Donohue	2nd place	
11 June 1972	Labatt's Blue Trophy	Milt Minter	4th place	
11 June 1972	Labatt's Blue Trophy	Peter Gregg	5th place	
9 July 1972	Can-Am Challenge Cup Race (Road Atlanta, USA)	George Follmer	1st place	1h 39' 36.2"
9 July 1972	Can-Am Challenge Cup Race	Milt Minter	3rd place	
9 July 1972	Can-Am Challenge Cup Race	Peter Gregg	5th place	
23 July 1972	Watkins Glen Can-Am	George Follmer	5th place	
23 July 1972	Watkins Glen Can-Am	Milt Minter	6th place	
23 July 1972	Watkins Glen Can-Am	Peter Gregg	11th place	
6 August 1972	Mid-Ohio Buckeye Cup Race	George Follmer	1st place	2h 4' 2.19"
6 August 1972	Mid-Ohio Buckeye Cup Race	Milt Minter	3rd place	
6 August 1972	Mid-Ohio Buckeye Cup Race	Peter Gregg	25th place	
27 August 1972	Can-Am Challenge Cup Race (Road America, USA)	George Follmer	1st place	1h 48' 40.2"
27 August 1972	Can-Am Challenge Cup Race	Milt Minter	7th Place	
17 September 1972	Can-Am Challenge Cup Race (Donnybrooke, USA)	Milt Minter	2nd place	1h 48' 4.75"
17 September 1972	Can-Am Challenge Cup Race	George Follmer	4th place	
17 September 1972	Can-Am Challenge Cup Race	Mark Donohue	17th place	
1 October 1972	Molson Can-Am Race (Edmonton, Canada)	Mark Donohue	1st place	1h 50' 26.09"
1 October 1972	Molson Can-Am Race	George Follmer	3rd place	
1 October 1972	Molson Can-Am Race	Milt Minter	21st place	
15 October 1972	Monterey-Castrol G.P.	Mark Donohue	2nd place	1h 34' 19.55"
15 October 1972	Monterey-Castrol G.P.	Milt Minter	4th place	
15 October 1972	Monterey-Castrol G.P.	Sam Posey	5th place	
15 October 1972	Monterey-Castrol G.P.	Willi Kauhsen	28th place	
29 October 1972	Los Angeles Times G.P.	George Follmer	1st place	1h 38' 31.65"
29 October 1972	Los Angeles Times G.P.	Mark Donohue	3rd place	
29 October 1972	Los Angeles Times G.P.	Peter Gregg	6th place	
29 October 1972	Los Angeles Times G.P.	Willi Kauhsen	8th place	
29 October 1972	Los Angeles Times G.P.	Sam Posey	24th place	
29 October 1972	Los Angeles Times G.P.	Milt Minter	27th place	
1 April 1973	ADAC 300km races (Nurburgring, West Germany)	Willi Kauhsen	1st place	1h 49' 36.3"

Porsche 917 and its Racing Record

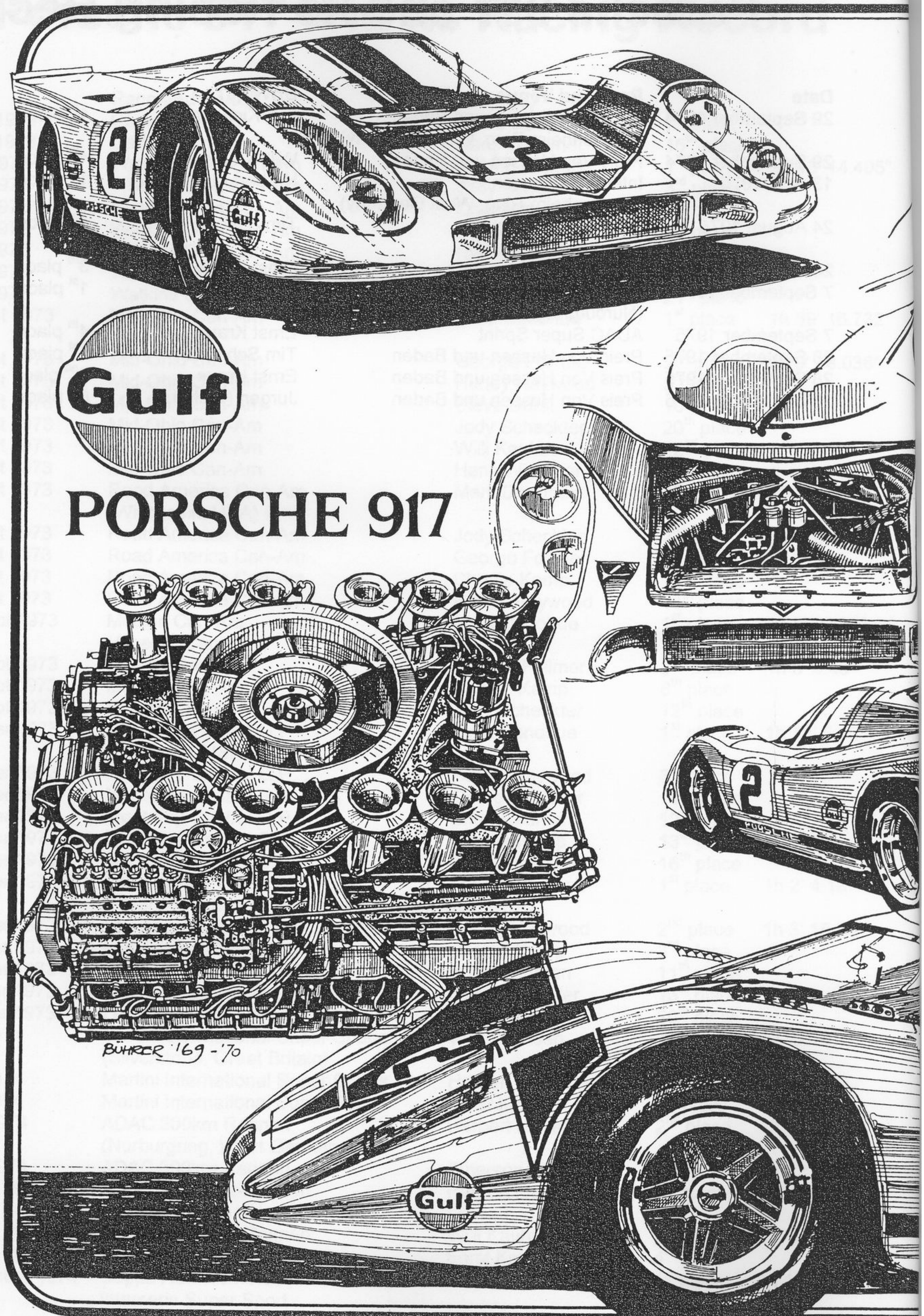
Date	Race and Venue	Driver(s)		
1 April 1973	ADAC 300km races	Leo Kinnunen	2nd place	
1 April 1973	ADAC 300km races	Ernst Kraus	5th place	
1 April 1973	ADAC 300km races	George Loos	6th place	
1 April 1973	ADAC 300km races	George Follmer	8th place	
1 May 1973	Shell Gold Cup (Imola, Italy)	Willi Kauhsen	1st place	1h 41' 26.8"
1 May 1973	Shell Gold Cup	Leo Kinnunen	2nd place	
1 May 1973	Shell Gold Cup	George Loos	3rd place	
1 May 1973	Shell Gold Cup	Ernst Kraus	4th place	
1 May 1973	Shell Gold Cup	Charlie Kemp	8th place	
20 May 1973	Martini International Super Sports 200 (Silverstone, Great Britain)	Leo Kinnunen	1st place	1h 32' 44.8"
20 May 1973	Martini International Super Sports 200	Willi Kauhsen	2nd place	
20 May 1973	Martini International Super Sports 200	George Loos	3rd place	
20 May 1973	Martini International Super Sports 200	Ernst Kraus	4th place	
20 May 1973	Martini International Super Sports 200	Gunter Steckkonig	6th place	
24 June 1973	Nurnberg 200 miles	Leo Kinnunen	1st place	2h 8' 45.1"
24 June 1973	Nurnberg 200 miles	George Loos	2nd place	
24 June 1973	Nurnberg 200 miles	Willi Kauhsen	4th place	
24 June 1973	Nurnberg 200 miles	Jurgen Barth	5th place	
24 June 1973	Nurnberg 200 miles	Ernst Kraus	6th place	
24 June 1973	Nurnberg 200 miles	Lasse Sirvio	9th place	
15 July 1973	South West Trophy (Hockenheim, West Germany)	Vic Elford	1st place	1h 19' 6.1"
15 July 1973	South West Trophy	George Loos	2nd place	
15 July 1973	South West Trophy	Ernst Kraus	3rd place	
15 July 1973	South West Trophy	Jurgen Barth	5th place	
15 July 1973	South West Trophy	Willi Kauhsen	6th place	
15 July 1973	South West Trophy	Lasse Sirvio	7th place	
15 July 1973	South West Trophy	Albert Pfuhl	8th place	
15 July 1973	South West Trophy	Leo Kinnunen	9th place	
19 August 1973	Adriatic Riviera Trophy (Santamonica, Italy)	Leo Kinnunen	1st place	1h 42' 37.5"
19 August 1973	Adriatic Riviera Trophy	Ernst Kraus	2nd place	
19 August 1973	Adriatic Riviera Trophy	Willi Kauhsen	4th place	
19 August 1973	Adriatic Riviera Trophy	Helmut Kelleners	5th place	
19 August 1973	Adriatic Riviera Trophy	Jurgen Barth	6th place	
19 August 1973	Adriatic Riviera Trophy	Lasse Sirvio	8th place	
30 September 1973	ADAC Baden-Wurttemburg (Hockenheim, West Germany)	Leo Kinnunen	1st place	1h 20' 6.3"
30 September 1973	ADAC Baden-Wurttemburg	George Loos	2nd place	
30 September 1973	ADAC Baden-Wurttemburg	Ernst Kraus	3rd place	
30 September 1973	ADAC Baden-Wurttemburg	Willi Kauhsen	4th place	
30 September 1973	ADAC Baden-Wurttemburg	Helmut Kelleners	5th place	
30 September 1973	ADAC Baden-Wurttemburg	Jurgen Barth	7th place	
10 June 1973	Labatt's Blue Can-Am (Mosport Park, Ontario, Canada)	Charlie Kemp	1st place	1h 48' 38.4"
10 June 1973	Labatt's Blue Can-Am	Hans Wiedmer	2nd place	
10 June 1973	Labatt's Blue Can-Am	Steve Durst	5th place	
10 June 1973	Labatt's Blue Can-Am	Mark Donohue	7th place	
10 June 1973	Labatt's Blue Can-Am	George Follmer	13th place	
10 June 1973	Labatt's Blue Can-Am	Hurley Haywood	15th place	
10 June 1973	Labatt's Blue Can-Am	Jody Scheckter	16th place	
7-8 July 1973	Carling Can-Am (Road Atlanta, Georgia, USA)	George Follmer	1st place	1h 55' 45.4"
7-8 July 1973	Carling Can-Am	Mark Donohue	2nd place	1h 56' 36.6"
7-8 July 1973	Carling Can-Am	Jody Scheckter	3rd place	
7-8 July 1973	Carling Can-Am	Hurley Haywood	5th place	

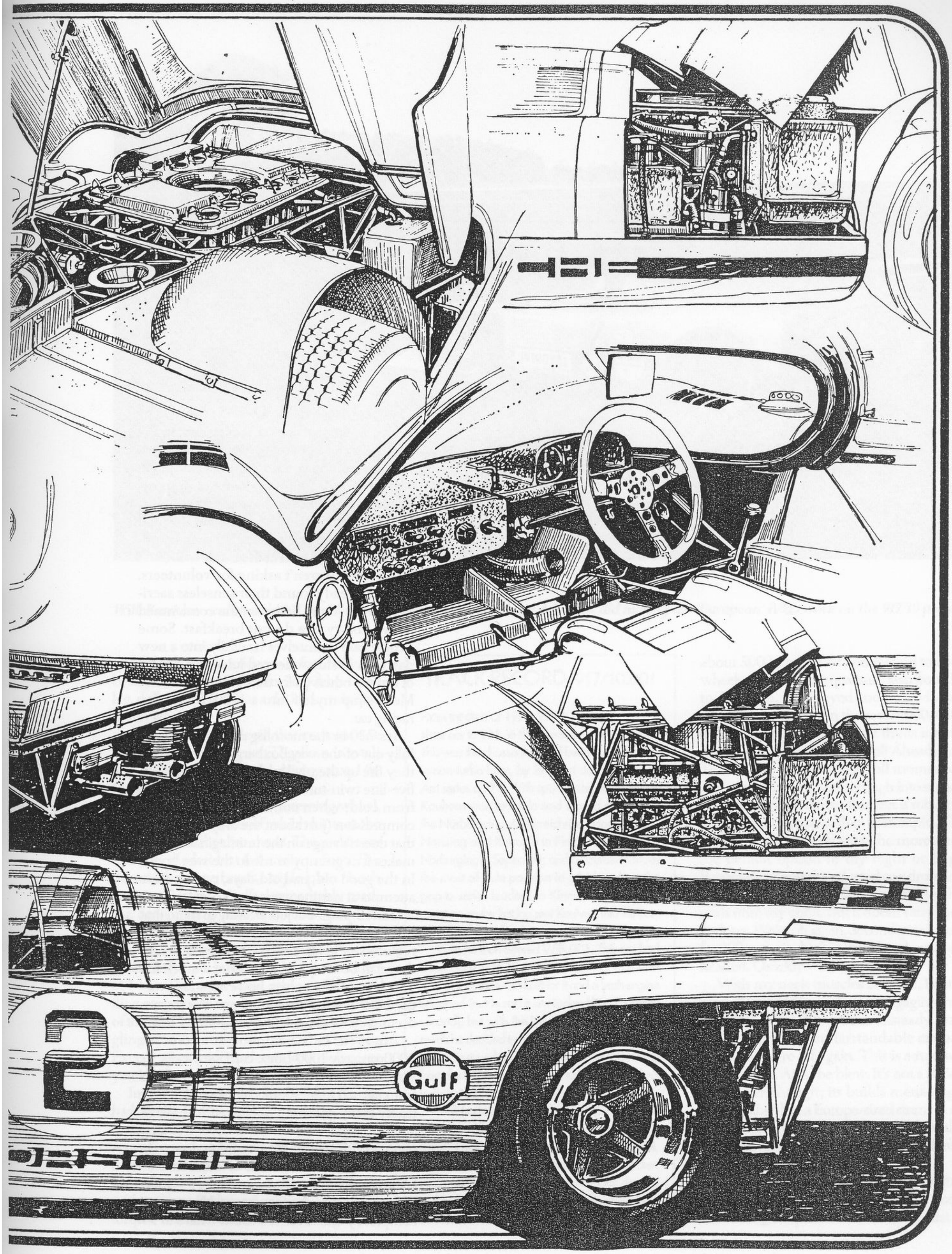
Porsche 917 and its Racing Record

Date	Race and Venue	Driver(s)		
7-8 July 1973	Carling Can-Am	Steve Durst	7th place	
7-8 July 1973	Carling Can-Am	Hans Wiedmer	16th place	
22 July 1973	Watkins Glen Can-Am	Mark Donohue	1st place	1h 43' 14.405"
22 July 1973	Watkins Glen Can-Am	Jody Scheckter	3rd place	
22 July 1973	Watkins Glen Can-Am	Charlie Kemp	4th place	
22 July 1973	Watkins Glen Can-Am	Steve Durst	7th place	
22 July 1973	Watkins Glen Can-Am	Hans Wiedmer	15th place	
22 July 1973	Watkins Glen Can-Am	George Follmer	20th place	
22 July 1973	Watkins Glen Can-Am	Hurley Haywood	21st place	
12 August 1973	Mid-Ohio Can-Am (Ohio, USA)	Mark Donohue	1st place	1h 59' 16.732"
12 August 1973	Mid-Ohio Can-Am	George Follmer	2nd place	2h 0' 48.038"
12 August 1973	Mid-Ohio Can-Am	Hurley Haywood	3rd place	
12 August 1973	Mid-Ohio Can-Am	Steve Durst	10th place	
12 August 1973	Mid-Ohio Can-Am	Jody Scheckter	20th place	
12 August 1973	Mid-Ohio Can-Am	Willi Kauhsen	22nd place	
12 August 1973	Mid-Ohio Can-Am	Hans Wiedmer	23rd place	
26 August 1973	Road America Can-Am (Wisconsin, USA)	Mark Donohue	1st place	52' 37.3"
26 August 1973	Road America Can-Am	Jody Scheckter	2nd place	53' 5.6"
26 August 1973	Road America Can-Am	George Follmer	3rd place	
26 August 1973	Road America Can-Am	Charlie Kemp	12th place	
26 August 1973	Road America Can-Am	Hurley Haywood	14th place	
15-16 Sept 1973	Molson Can-Am (Alberta, Canada)	Mark Donohue	1st place	1h 8' 22.75"
15-16 Sept 1973	Molson Can-Am	George Follmer	2nd place	1h 8' 9.46"
15-16 Sept 1973	Molson Can-Am	Charlie Kemp	8th place	
15-16 Sept 1973	Molson Can-Am	Jody Scheckter	12th place	
14 October 1973	Monterey-Castrol G.P. (California, USA)	Mark Donohue	1st place	1h 13' 5.49"
14 October 1973	Monterey-Castrol G.P.	Hurley Haywood	3rd place	
14 October 1973	Monterey-Castrol G.P.	George Follmer	11th place	
14 October 1973	Monterey-Castrol G.P.	Brian Redman	12th place	
14 October 1973	Monterey-Castrol G.P.	Charlie Kemp	13th place	
14 October 1973	Monterey-Castrol G.P.	Jody Scheckter	16th place	
28 October 1973	Los Angeles Times G.P. (Riverside International Raceway, California, USA)	Mark Donohue	1st place	1h 2' 4.18"
28 October 1973	Los Angeles Times G.P.	Hurley Haywood	2nd place	1h 3' 15.04"
28 October 1973	Los Angeles Times G.P.	Charlie Kemp	3rd place	
28 October 1973	Los Angeles Times G.P.	Brian Redman	11th place	
28 October 1973	Los Angeles Times G.P.	Jody Scheckter	13th place	
28 October 1973	Los Angeles Times G.P.	George Follmer	20th place	
12 May 1974	Martini International Super Sports (Silverstone, Great Britain)	Willi Kauhsen	1st place	47' 53.4"
12 May 1974	Martini International Super Sports	Herbert Muller	2nd place	48' 5.3"
12 May 1974	Martini International Super Sports	Ernst Kraus	4th place	
17 June 1974	ADAC 300km Rennen (Nurburgring, West Germany)	Herbert Muller	2nd place	1h 9' 22.5"
17 June 1974	ADAC 300km Rennen	Emerson Fittipaldi	6th place	1h 12' 22.5"
18 August 1974	ADAC Flugplatz-Rennen (Kassel-Calden, West Germany)	Herbert Muller	1st place	47' 52.4"
18 August 1974	ADAC Flugplatz-Rennen	Willi Kauhsen	2nd place	48' 3.1"
18 August 1974	ADAC Flugplatz-Rennen	Enrst Kraus	4th place	
22 September 1974	Coppa Autodrome Casale Interserie Super Sport (Italy)	Herbert Muller	1st place	1h 14' 17.4"
22 September 1974	Coppa Autodrome Casale Interserie Super Sport	Willi Kauhsen	4th place	

Porsche 917 and its Racing Record

Date	Race and Venue	Driver(s)		
29 September 1974	Preis Von Hessen und Baden (Hockenheim-Ring, West Germany)	Leo Kinnunen	1st place	
29 September 1974	Preis Von Hessen und Baden	Willi Kauhsen	4th place	
13 April 1975	Interserie Rennen (Hockenheim-Ring, West Germany)	Herbert Muller	1st place	43' 42.3"
24 August 1975	North Sea Trophy (Zandvoort, Holland)	Tim Schenken	1st place	
24 August 1975	North Sea Trophy	Ernst Kraus	3rd place	
7 September 1975	ADAC Super Sprint (Nurburgring, West Germany)	Tim Schenken	1st place	40' 46.1"
7 September 1975	ADAC Super Sprint	Ernst Kraus	4th place	
28 September 1975	Preis Von Hessen und Baden	Tim Schenken	1st place	
28 September 1975	Preis Von Hessen und Baden	Ernst Kraus	2nd place	
28 September 1975	Preis Von Hessen und Baden	Jurgen Neuhaus	6th place	


Gulf
PORSCHE 917
BÜHRER '69-'70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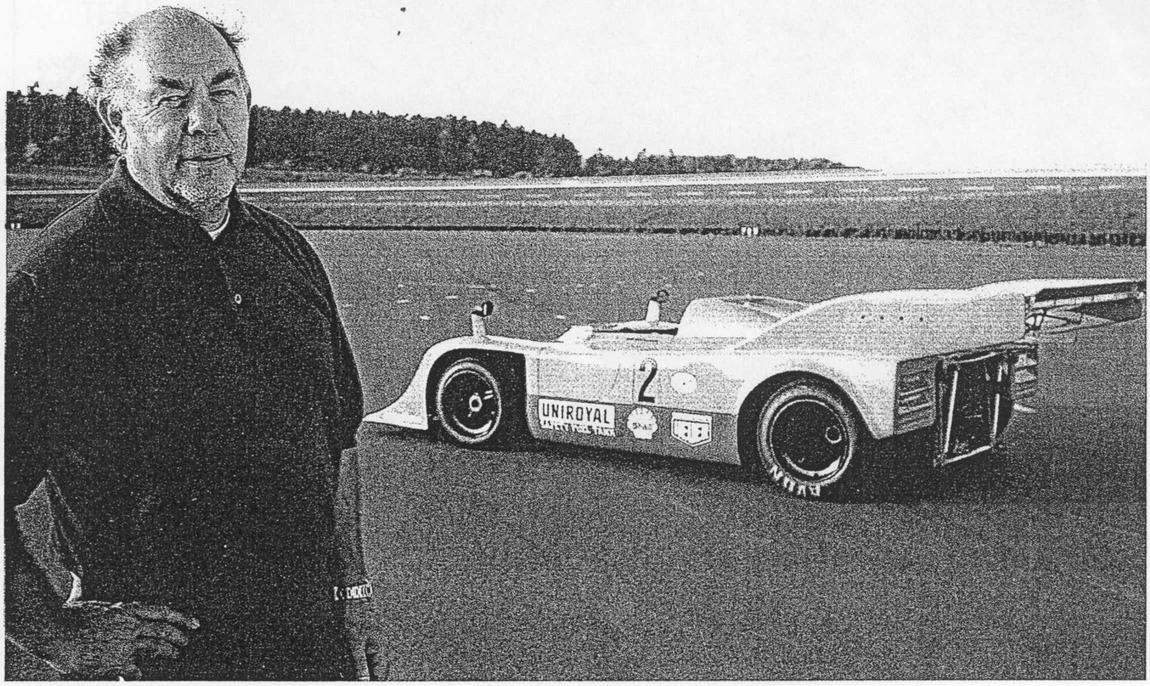
Gulf
PORSCHE

OKAY, SO THE 200MPH WARNING SIGNS WERE there: an engine note that registers on the Richter scale; a power-to-weight ratio capable of punching you through the exosphere – and beyond; a hitman's sense of purpose. But into that mix you have to factor… me. Had they been asking for volunteers I would have skulked at the back rather than be oo-oo-me-me-ing down at the front.

But they weren't asking for volunteers. They'd already found their senseless sacrifice… me. I'd not had even the condemned man's luxury of a decent breakfast. Some people ease themselves healthily into a new day with freshly squeezed juice and a bowl of muesli; others go for the caffeine kick-start. Me? I strap myself into a 1000bhp sports-racing car.

It's 7.30 in the morning at Bosch's thankfully out-of-the-way Boxberg test track when they fire up the pool table-sized flat-12. This five-litre twin-turbo runs Texas oil baron rich from cold; when combined with its 6.5:1 compression (just about the only spec figure that doesn't verge on the unimaginable), this makes it as grumpy as me in the wee hours. In the good old, bad old days, two or three attempts at starting were all you got before it was an all-plugs-out job. Bearing in mind that there are 24 of these, the front four of which require you to slide the engine back before they can be swapped, this is not a quick fix. Thanks to modern plugs, however, and a practiced hand on the throttle linkage, this is a rare occurrence these days. Today included. Curses!

After four or five minutes at a constant 3000rpm, my 1000-horse carriage awaits. Its vast, one-piece rear bodywork section, which from certain angles looks like a particularly tricky crazy golf hole, is clicked into place and the hinged-forward driver's door is swung open. Willi Kauhsen, the charming man who 30 years ago did thousands of kilometres of testing in this very chassis, and who's owned it since 1972, beckons me over. He appears completely unconcerned about what's to ➻



Willi Kauhsen and chassis 001 go way back. As Porsche's official test driver, he did most of the 'European' R&D work on the 917/10 project

come. Such is his confidence in fact, he's even brought some wets with him: 1000bhp, turbo lag, differential-less rear axle, in the rain? No thank you.

I step over the wide sill that contains one of the massive fuel tanks (77 gallons in total) and plonk myself into the driving seat. I fit. Curses again!

I'm behind an Abarth (!) steering wheel, the plentiful diameter of which hints at the muscular ride that lies ahead. The pedals are offset to the left but fall easily to foot. The throttle is meaty, but the triple-plate clutch and unservoed brake feel remarkably road-car. Seen through the top half of the three-spoke wheel is a VDO rev-counter that's red-lined at 8400rpm; to its right, canted-in at a gentle angle, is a boost gauge that's red-lined at 1 bar. There are some other smaller, piffling gauges – oil temp, water temp, that sort of thing – but it's impossible to peel your goggling eyes from the big ones that matter. Except when you accelerate, at which point you involuntarily scan the heavens.

In pull-left-and-push forward first the car had shunted unfussily through the two automatic barriers that lay between it – and me – and the wide-open sweeps of the 1.9-mile banked oval. But that same ratio is also good for 110mph – it's amazing what you can do with a Giant Redwood-pulling 720lb/ft of torque. Willi had advised that I change up at about 5000rpm in first and second to avoid wheelspin during the quantum leap from 380 to 1000bhp. Eagle-eyed and pussy-footed, therefore, I squeeze on the revs: 4000, 4500, 4750. Sky! My crash helmet thuds into the roll-hoop as the turbos go Full Ahead Both. Thankfully, the same rag-doll momentum sees me pull, semi-auto, through into second. Four-speed, all-synchro, this unit is robust (as you might expect) rather than rapid. This fact, when combined with the more sensible default option in my Fight or Flight Response, means the selected cog drops into mesh just as I drop off the boost. My chin nods onto my chest. But it doesn't stay there for long. We're off again. Second gear is good for 150mph – which is exactly where we're headed. Quickly.

With my neck muscles boosted, I determinedly see 6000rpm before engaging third (good for 190mph!) with an unsteady hand. And, despite my understandable circumspection, we're off again. This is a runaway train of a car. And she blew. It's not a shrieking power, though; its builds menacingly, unstoppably, like a Europe-sized storm in the Caribbean. This is the car, remember, that crashed into America and swept all before it. This is the car you can see from space.

When Mark Donohue, clean-cut Captain Nice, the racing driver who probably could have brought Apollo 13 home safely, first ➻

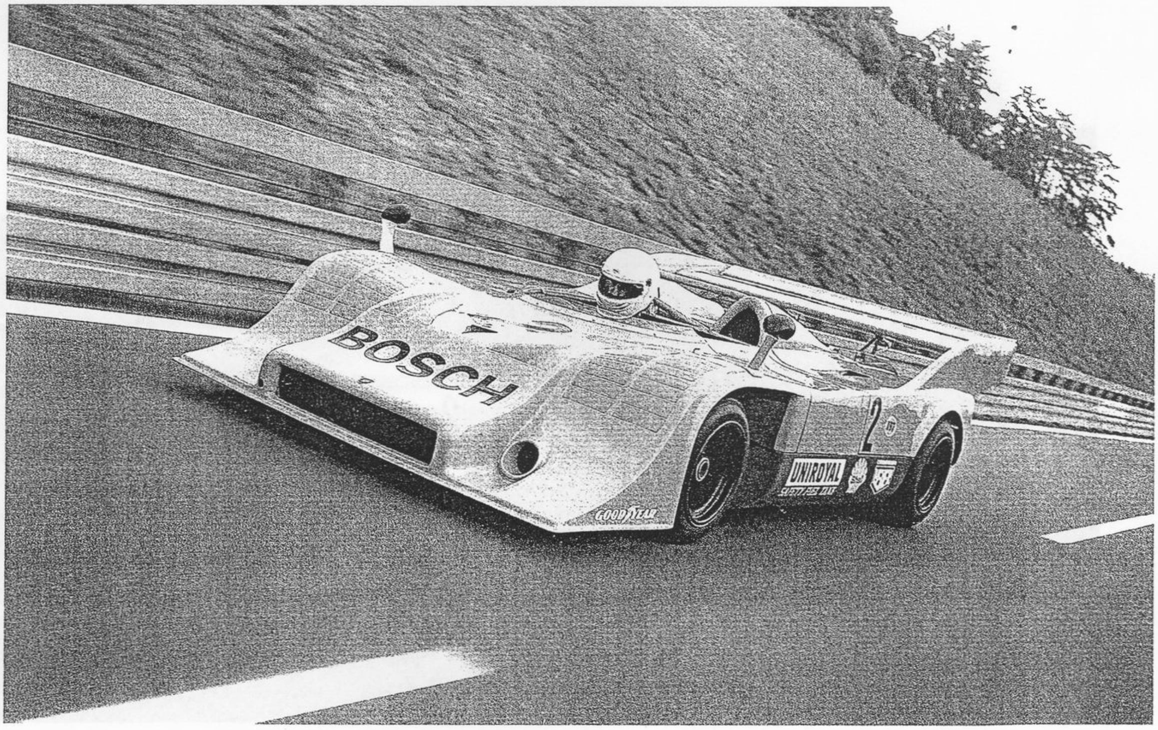
TRACK RECORD: 917/10.001

FROM THE START OF 1972, WILLI KAUHSEN RACED 002, sister car to 001, in the Interserie championship. This was the chassis that had been campaigned, in non-turbo form, by Jo Siffert during the Can-Am series of '71. With sponsorship from Bosch, Kauhsen won at Imola and scored seconds at the Nürburgring, Osterreichring, Hockenheim, Norising and Keimola in Finland. Back at the Nürburging in September, and desperate to make the most of pole position in a bid to close the gap to series leader Leo Kinnunen (in 004), a puncture on the first lap sent Kauhsen into the barriers. On full tanks, the car was burnt to a crisp.

Porsche then offered Willi 001. This car had done more than 10,000km of testing, and so a new spaceframe was built for it and a fresh engine dropped in. He ran it at Hockenheim (another second), but with the Interserie title beyond his reach he decided to contest the Laguna Seca and Riverside rounds of the Can-Am series. He retired from the former with a blown turbo, and finished a distant eighth in the latter.

Willi had a new chassis for 1973 (015), so 001 was loaned for one Interserie race each to Charlie Kemp, Günther Steckkönig and Wilson Fittipaldi.

The car now had one more race in its locker. In July 1974, the more famous Fittipaldi drove it at the 'Ring: he put it on pole, but finished sixth.



Main front aperture holds oil cooler. Nose actually gave too much downforce causing an aerodynamic imbalance - sorted on 917/30 of 1973

drove the turbo version of this car (chassis 001, the project's development hack) it scared him half to death – once they'd got the damn thing started. Porsche wasn't introducing turbocharging to racing – Offys had done that at Indy five years before – but it *was* the first to adapt this format to stop-start, on-off road courses rather than rolling-rolling-rolling, full-throttle ovals. And just months before the first race for its 917/10, the car was nowhere near race-ready. Its throttle was a lightswitch – with a delay. Now you see it, now you don't, now you see it… And we're talking 600 extra horsepower here, not 40 feeble watts. In a car with a short wheelbase (2100mm) and weighing 810kg (100 more than the McLaren M20), this power delivery was a recipe for disaster.

But not only was Porsche wrestling with turbo lag, it was also getting to grips with big wings and massive slicks for the first time. Low-drag had been its (successful) policy until now, but with more than 750bhp at their disposal, the Chevy boys of Can-Am had fast learned the benefits of downforce. Donohue was aghast when engineer Helmut Flegl explained how Porsche had no plans to fit a rear wing to the car. Initially dumfounded, by the time he was halfway home Donohue had half-convinced himself that Stuttgart must have a secret ground-effect scheme up its sleeve. At which point he unconvinced himself and diverted back to Stuttgart to impress upon Flegl the need for a wing. Thankfully for him – and me – he and Don Cox, Penske's razor-sharp tech chief, came up with a convincing argument.

I can certainly feel it working now, that snowplough nose digging in ever harder, that crashing-wave rear wing squashing and trimming. It was reckoned that the car generated its own weight in downforce at 180mph; I, of course, am going nowhere near that quickly. It all feels remarkably planted, though, rock-solid courtesy of inch-thick rollbars and 600lb springs front, 800 rear.

Confidence building, I attempt an experimental jab on the middle pedal. The car tramlines as the not-yet-warm, Porsche-built four-pot calipers grab at vented, cross-drilled discs. A nice, steady, one-two downchange follows and I hold the revs at the slump end of the boost. And then boom! The needle flicks to 0.9 bar (about 900bhp) and I'm pinned back – from a 100mph rolling start, in third! This is what I'm missing by running on the oval: the neck snap, overrun crackle and turbo pop of braking, cornering and acceleration. (I had hoped to drive on the handling course, too, but it proved a mite twee for a car that is almost as wide as it is long.)

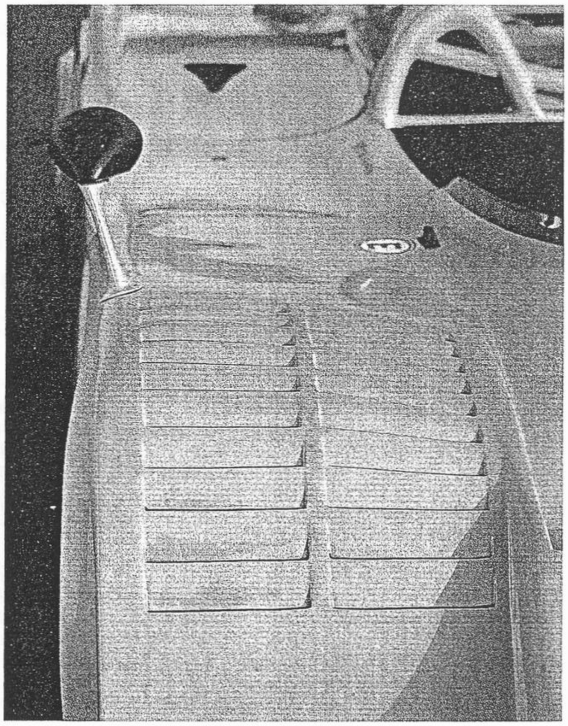
The handling was another aspect that had failed to impress Donohue on his early runs. The unsorted 917/10 had an unnerving habit of weaving at high speed, while corners had to be taken in two or three stabs rather than one smooth sweep – and that was with a 5.4-litre atmo engine amidships! Donohue and Cox lengthened the front wishbones to reduce camber change and stabilise the contact patch, and the rear roll-centre was raised: the car was now more manageable, if not totally perfect.

I had expected it to be truly terrifying, to shoot off at right angles, to swap ends, given even a smidgen of throttle. But that, when I thought about it latterly, was an irrational fear. The M20 of 1972 was the latest in a long line of McLaren Can-Am beauties: it had 800bhp, a monocoque chassis, and its drivers and team were imbued with years of domination. To beat it you would require a finely honed racing car, not an untameable monster. And this Porsche beat it.

"I drove a McLaren M8 on the Porsche test track," admits Kauhsen after 30 years, "and it was much, much nicer to drive than the 917/10. Much easier. But there was no way, no way, that it could live with the Porsche when Mark Donohue was at its wheel. He was fantastic." Donohue's driving style was to carry speed deep into a corner; for him, there couldn't be enough power or downforce. "I remember the first time I saw him in the car," Kauhsen continues. "He came into the S-bend sideways, changed up in ➸

TECHNICAL SPECIFICATION

ENGINE
Type: T912 – air-cooled, DOHC, flat-12 **Capacity:** 4998cc
Bore x stroke: 86.8 x 70.4mm **Compression:** 6.5:1 **Ignition:** Bosch; twin-spark heads **Fuel injection:** Bosch **Max power** 1000bhp @ 8400rpm **Max torque:** 720lb/ft @ 6500rpm **Construction:** magnesium crankcase, steel crank running in eight plain main bearings, central power take-off and cam drive (gears); aluminium cylinder barrels and two-valve heads (65-deg valve angle: valves sodium-cooled); 5in titanium conrods, Mahle pistons in Nikasil bores; magnesium camboxes
Weight: 284kg **Turbos:** KKK, one per bank **Max boost:** 1.4 bar
Oil system: dry sump **Cooling fan:** 13in, running at 1.4 engine speed, 3100 litres/sec **Firing order:** 1-5-12-3-8-6-10-2-7-4-11
DRIVETRAIN
Gearbox: T920 – 4-speed, synchro **Clutch:** Borg & Beck, triple-plate, 7.25in **Final drive:** solid spool, locked titanium halfshafts, rubber donuts
CHASSIS
Type: aluminium spaceframe stiffened by aluminium sheet (65kg)
Bodywork: GRP **Wheelbase:** 2316mm **Track (f/r):** 1620/1638mm
Weight: 810kg **Length/width/height:** 4350/2100mm/1120mm
RUNNING GEAR
Suspension (f): double-wishbone, forward-facing radius arms, spring/damper unit, anti-roll bar **Suspension (r):** reversed lower wishbone, top link, twin radius arms, spring/damper unit, anti-roll bar
Hubs: titanium **Dampers:** Bilstein **Springs (f/r):** 600/800kg
Brakes: Porsche, four-piston trailing calipers; aluminium discs, vented and cross-drilled **Steering:** rack-and-pinion **Fuel capacity:** 77 gallons
Wheels: Porsche, 15in **Tyres (f/r):** Goodyear, 12/19in
PERFORMANCE
0-60mph: 2.1sec **0-100mph:** 3.9sec **0-200mph:** 13.4sec



Slats in front wing cooled brakes and generated negative pressure

the middle of it, and was gone. I thought he'd made a mistake, but he did exactly the same thing on the next lap, and on the next. He drove like it was a go-kart. He was only a tenth quicker than me, but it was a very short lap at Weissach and I had done thousands of kilometres there. I knew then that I would have to change my driving style. But I could not. I could get the car a little sideways, too, but only when I saw the exit of a corner. To be quick in this car you had to be aggressive with it, on the brakes and on turn-in, and Donohue was the master of that."

If Kauhsen is the unsung hero of this immense project – testing, testing, testing – Donohue is The Man, in and out of the car. When the turbo engine, fresh from flash readings of 1500bhp on the dyno, continued to refuse to run at low and mid-range revs it was Donohue who asked if it had ever been tuned to run minus the turbos. The answer was no. His request that the Porsche engineers return to the absolute basics paid dividends. No longer blinded by those flash readings, they, and Bosch, took a more measured approach to factoring in a new, third parameter to what we now know as engine management: boost, as well as throttle opening and rpm. The resultant fuel injection control cam was not much bigger than a 50p piece but it floated this million-pound project. The resultant fuel pump became known as the 'happy pump', and Donohue cracked one of his famous smiles – now he had a car he could race with.

This is the 'user-friendliness' which I'm benefiting from today, 31 years later. The boost is epic in its scope and scale, but it does not come in as aggressively as that of the Porsche 956 I drove last year. It's fatter, plumped out by all that torque.

I'm on my second run now and I'm beginning to enjoy myself. I espy a Merc in the middle-distance and prepare to pour past it. I don't, though; our speed differential appears to be not much more than 20-30mph. (It doesn't occur to me that the Merc might have been doing 140 or so!) I decide to speed up – well, the mechanics are watching this time. Another 500rpm is spooled out. Approx 7000rpm. Storm's a-brewing.

We're really shifting now and I lift for the tighter of the bankings – the circuit is cam-shaped; my neck feels the braking effect of of that rear wing. The longer 'base circle' banking I can take without a lift – not that I'm flat-out, mind. Even so, I'm definitely having to steer and I feel my biceps bulge (a relative term). The buffeting has just begun, too, that thin strip of a deflector along the cockpit coaming having worked wonders.

Another 500rpm. Faster, faster, faster...

Time to stop.

I'm all alone briefly back in the paddock. I allow the turbos to cool, then switch off. Their impellers, which run up to 100,000rpm at full load, whir on for 10sec or so. My back acts as a heat sink and a shimmering haze passes overhead. Blimey, I've got it warm – a fact confirmed by one of those piffling dials. I hop out and feel the tyres. Hot-ish. Wonder how fast I went?

Willi returns. I ask him what the car is geared to: 345km/h at 8400rpm, he replies. The tell-tale is wedged at 7600rpm. I ask to borrow a calculator.

That's 41.07 km/h per 1000 revs. Times 7.6. Equals 312.14km/h. Multiply by 0.6214 to get mph. That's... No way!

I show the calculator read-out to Willi. He shrugs, unconcerned: "For sure, yes."

"But it didn't feel that fast," I venture, almost by way of an apology.

"That's the problem with this car – it does not feel fast, it does not sound."

Exactly how fast?

An unofficial 193.96mph.

Running 10 per cent shy of a racing car's maximum is no reason to boast. Sure, I've almost joined The 200mph Club, but there is no disappointment, just an overwhelming sense of humility: I am in the presence of greatness.

Porsche's 917/10 is unquestionably a car that redefined the sport's boundaries. It can take you to places you've only dreamed of.

I know, I've been.

Le Mans Practice

The BOAC 1000 detracted considerably from Le Mans activity, but there were interesting technical developments by Porsche, Ferrari and Alfa Romeo. No serious French contenders present

IT is a measure of the importance of the BOAC 1000 that the traditional Le Mans weekend was a very sorry affair compared with previous years. Even last year, when the two dates coincided, the main teams were able to find the means and the times to do a great deal of useful work in the two-day test period. With the total withdrawal of the Alpine Renaults—the *Régie* have decided that it is bad publicity to continue without the hope of victory—and with Matra fully occupied at Brands Hatch, the only French car present was the little Cosworth FVA powered, 1,791 cc Ligier. Ferrari could only spare one 512S and the mechanics who normally look after the customers' cars. Alfa Romeo were in the same position, sending one Type 33 but with some of the engineering "top brass" from the factory to monitor a series of experiments in ride height and aerodynamics.

Only Porsche had set themselves out to do an elaborate job, arriving with two 917s, about 20 mechanics and technicians and an array of different body sections.

Porsche had pulled out all the stops to make a second version of their new, high-speed body after Ahrens' aquaplaning crash at the Wolfsburg test track early in the week. This new porpoise-like body shape is aimed at inhibiting lift increases as the angle of incidence of the body changes with pitching. I learnt that last year's body had a lift increment of 77kg per one degree of positive incidence. This explains a lot of the handling problems last year, as well as Udo Schutz's sensational crash. Interesting features of this body are the carburettor air intake slots with heavily lipped edges set athwartships in a high pressure area behind the cabin in front of a small brake air intake. The general shapes of these intakes look more like the efforts of a sanitary ware manufacturer than those of a car designer. Cooling air is extracted from a transverse slot underneath the car. The car's shape is said to be so good that the turbulent wake closes up 1.5 metres behind the car, making slipstreaming a fruitless occupation, quite apart from the reduction in drag.

Herbert Linge was driving this car, but the effort of setting up a completely new chassis meant that he did not do a flying lap, so the real potential of the car was not made public. The other 917, with Brian Redman up, was tried with the 1970 version of last year's tail incorporating the controversial "clopets", to get reference lap times, then with a new tail with long straight decks on each side of the air intakes and tiny spoilers. Looking decidedly angular compared with the curvaceous other 917, it nevertheless returned fastest time of the Saturday trials.

Jackie Ickx had bad luck when, on his first lap with the 512 which was fitted with a tail nearly as high and wide as a peacock's, a stone jammed between the disc and caliper of his right-hand rear brake and cracked off the calliper lugs. A couple of hours were lost while a new wheelpost was fitted. In the prevailing wet conditions Ickx then went out and tried the two tails, the high one first and a second long, clean one, devoid of spoilers. His best time, 3min 34sec, was made using this latter version. Incidentally this car was fitted with ultra low profile Firestones with rims about $1\frac{1}{4}$ times the width of the treads.

There is an air of greater efficiency about the Alfa Romeo efforts these days. Ing Busso, who worked closely with Sata on the 158, was keeping an eye on a series of runs, with Zeccoli driving, to check the effect of long and short tails on lift. Transducers on the suspension and on the engine and transmission transmit signals by vhf radio to a recorder in the pits. Readings were taken of oil pressure and temperature, car speed and body position. On Firestone tyres Zeccoli was consistently fast, recording fastest time in the morning with a 4min 0.8sec lap and third fastest of the day in the afternoon with a time of 3min 36.5sec. Fourth fastest was Tony Pilette in the Racing Team VDS Lola T70 Mk3B, after having spent some time marooned at the back of the circuit with an engine bother.

Unfortunately the Mazda-engined Chevron was not ready in time. Nor were any small engined cars other than the Ligier, which is a handsome little plastic-bodied GT car powered by a Cosworth Ford FVA engine. Apart from the 1204cc Moynet and Paul Watson's 1791cc Chevron-Cosworth, it will be the smallest-engined car in the race. A lot of serious people feel that it is a good thing that the bottom limit is about two litres, thereby reducing the speed differential in a race where a number of the more powerful cars will not be in the most experienced hands. □

PRACTICE TIMES—11 April 1970

No.	Car	Driver	Time Min. Sec.	Speed MPH
22	Porsche 917	B. Redman	3 33.5	141.2
5	Ferrari 512	J. Ickx	3 34.0	140.8
37	Alfa Romeo	T. Zeccoli	3 36.5	139.1
4	Lola T70 Mark 3B	T. Pilette	3 51.9	129.9
35		J. Juncadella	3 58.6	126.3
62	Porsche 907	D. Rouveyran	4 04.6	123.3
1	Chevrolet Corvette	J. C. Aubriet	4 14.2	118.5
55	Ligier J.S.	G. Ligier	4 28.9	112.0
65	Porsche 911 S	C. Haldi	4 35.9	109.1
48	Porsche 908	H. Linge	4 36.6	108.9
67	Porsche 911 S	J. M. Nourry	4 47.0	104.9
63	Porsche 911 S	R. Mazzia	4 50.4	103.7
43	Porsche 911 S	S. Garant	4 53.1	102.7
68	Porsche 911 S	J. Dechaumel	4 54.4	102.3
21	Porsche 917	H. Linge	4 54.5	102.2

PORSCHE 917

Having achieved its prime objective—winning Le Mans for Porsche—the 917 is now obsolete and already a legend in its own time. Now rumor is rife of a new 5-liter Porsche production car

□ As the 1971 motor racing season draws to a close the Porsche 917 is approaching obsolescence, outlawed by a change of regulations governing a category of racing in which it has been involved for three years and which it has dominated spectacularly for the past two.

The 917, during its impressive if relatively brief career, has taken part in 20 endurance races counting toward the FIA's International Championship for Makes (more popularly referred to as the Manufacturers Championship), and has won outright no fewer than 15.

But the Porsche 917 was conceived to do more than just win races, and it has succeeded as admirably in its other objectives as well. It was intended to be the car which was to give the German company its long dreamed of victory at Le Mans. It failed at its first attempt, which in any case was considered to be a "dummy run" pending the further development of the car's handling qualities (its speed had never been in doubt). But it succeeded convincingly in 1970 and again in 1971.

Its other major objective was less tangible. It was to be the car which was to identify the Porsche factory as a manufacturer of very powerful, large-displacement cars. Throughout the company's existence there has been a slow but steady increase in the engine displacement of its products, stemming from the original 1100 (1086 cc) design through the 1300, 1500, 1600, 2 liter, 2.2 liter, 2.4 liter and 3.0 liter, all of which had played a dominant role in their respective racing classes, and the majority of which have found their way into the Porsche production car catalog.

Invariably it has been the racing model which has preceded its road-going counterpart, sometimes by several years, and so it is reasonable to assume that one factor behind the development of the 917, first with a 4.5-liter flat-12 engine and more recently with a 5.0-liter version of the same power unit, is the company's long-term intention to invade the larger-displacement passenger car market.

A measure of the 917's impact is reflected in the fact that whereas four years ago the suggestion of a 5-liter road-going Porsche in direct competition with Ferraris, Maseratis, Lamborghinis and the rest would have been somewhat laughable, today the suggestion is by no means preposterous. Indeed, rumors of such an event are as rife as those perennials which suggest an imminent return by Porsche to Formula 1 racing. Of the two events, the large-displacement street Porsche is by far the more likely.

Not that if or when such a car appears it is likely to have much in common with the 917, which was designed specifically to conform to the FIA's regulations for Sportscars, and was adjudged by Porsche's engineers to exploit them to the full. The subsequent race history of the car has proven that their faith in their design concept was fully justified.

The car was unveiled, not on a racetrack, but in the most unlikely surroundings of the Geneva Show. Admittedly it was displayed on an angled platform in a section devoted to competition cars, but nevertheless its impact was such that it became the star of the show as a whole.

Like Porsche's other successful endurance-race cars, it had a multi-tubular chassis of light weight but considerable rigidity, clothed in a thin-skin fiberglass body, in this case a closed-top streamlined coupe offering the minimum in drag, if undetermined high-speed stability.

The engine was an air-cooled flat-12 cylinder, with the same cylinder dimensions (85-mm bore, 66-mm stroke) as applied on both the flat-eight 3-liter engine of the 908 and the flat-six 2.2-liter power units used more recently for the competition 911S. To insert such an engine and its transaxle into a reasonably compact space and still leave room for the driver and his controls was a considerable achievement of packaging, and moreover it was attained in conjunction with a not un-

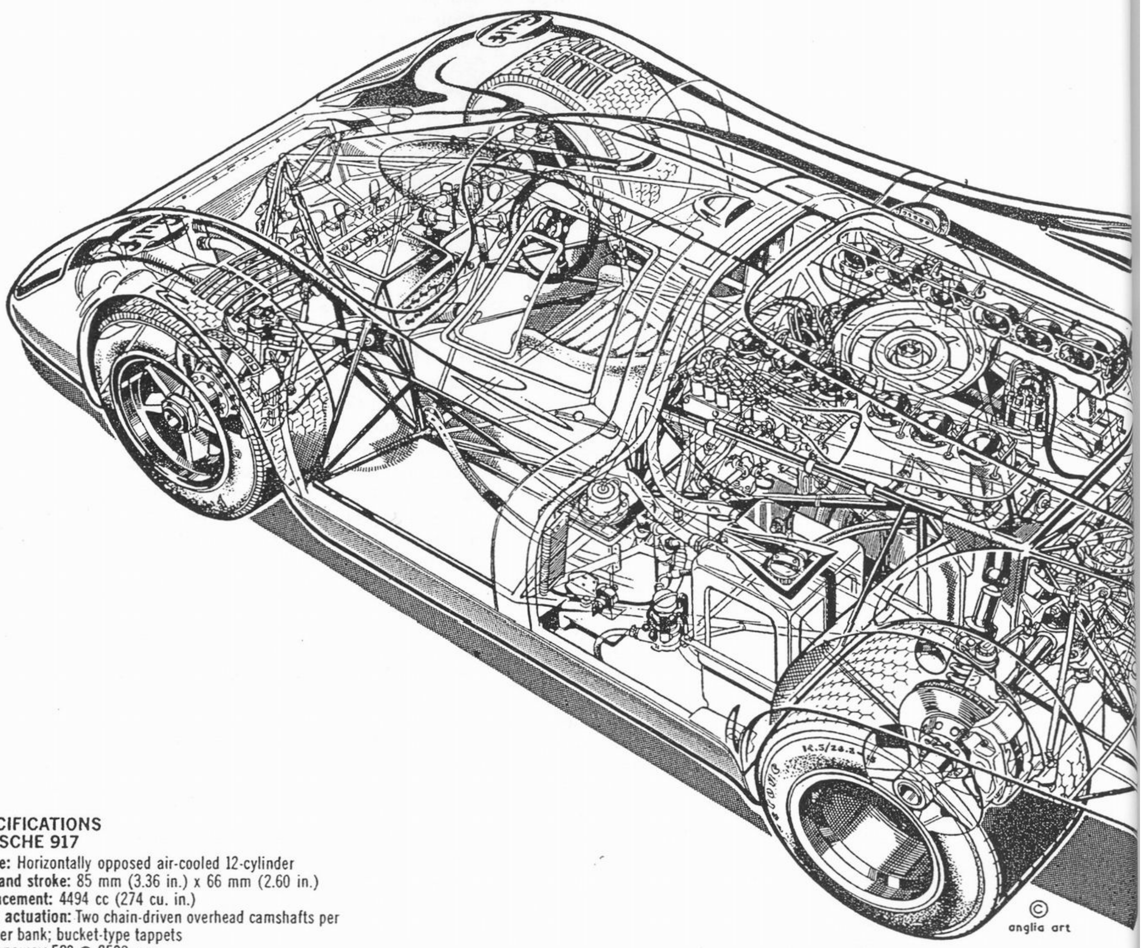
917s at '71 Spa 1000 Kms, with winning Rodriguez/Oliver #21 and second-place Siffert/Bell #20.

reasonable weight distribution between the front and rear wheels of approximately 40/60 percent, while the all-up weight of the car was in the region of 2000 pounds on the starting grid. With something like 520 bhp on tap at 8500 rpm, therefore, the 917 was quite a projectile.

Perhaps not surprisingly, it was also something of a handful. Since the prime objective of the Porsche factory team during 1969 was to win the Manufacturers Championship, for which purpose they had prepared a very competitive fleet of 3-liter 908 coupes and spyders, the chassis development of the 917 proceeded only slowly during the first few months, when the endurance racing season was at its height.

The 12-cylinder car made a very brief race debut in the Spa 1000 Kilometers race, where it retired with a sick engine, but two 917s plus a third private car were entered for Le Mans the following month, with controversial movable spoilers attached to the long-tailed bodywork. The organizers considered this to be rule-bending, but they allowed the cars to start after it had been argued that to race the cars without the aerodynamic devices would be hazardous on such a fast circuit. But even so there was tragedy on the opening lap when John Woolfe crashed his privately entered car and was fatally injured. One of the works cars was delayed by oil on the clutch and eventually retired after half-distance, while the other 917 was holding a five-lap lead on Sunday morning when it, too, was withdrawn with an oil-soaked clutch.

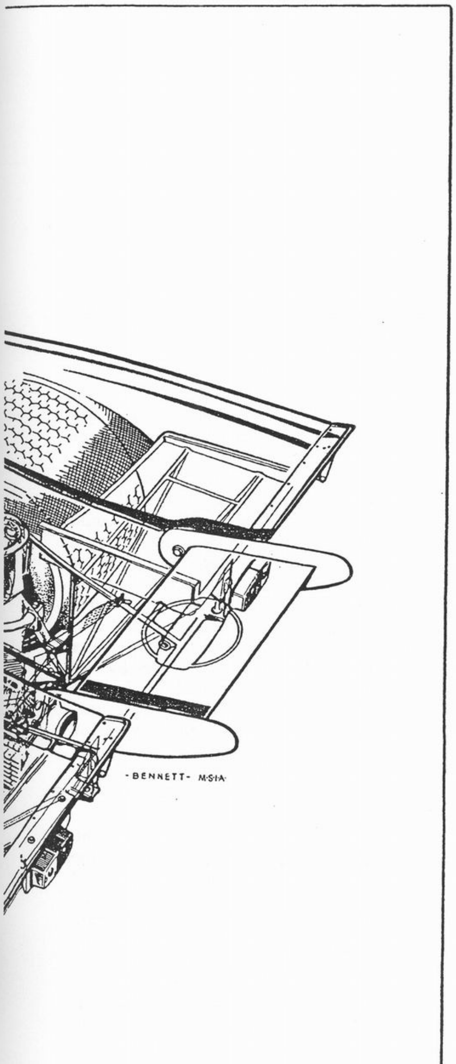
The 917's third race and its first victory came in the last championship race of the season, the 1000 Kilometers race on the Osterreichring, near Zeltweg, Austria, when Jo Siffert and Kurt Ahrens shared the winning car. But the big Porsche was still something of a handful, and after the race the team remained behind for some development testing, where they were joined by John



SPECIFICATIONS
PORSCHE 917

Engine: Horizontally opposed air-cooled 12-cylinder
Bore and stroke: 85 mm (3.36 in.) x 66 mm (2.60 in.)
Displacement: 4494 cc (274 cu. in.)
Valve actuation: Two chain-driven overhead camshafts per cylinder bank; bucket-type tappets
Horsepower: 520 @ 8500 rpm
Peak torque: 333 lbs.-ft.
Compression ratio: 10.5 to 1; fuel injection by 12-piston double-bank pump
Gearbox: Porsche 5-speed
Chassis: Multi-tube frame constructed of precision lightweight metal
Bodywork: Polyester-reinforced fiberglass
Net weight: 1962 lbs.
Top speed: 236 mph (Long-tail version)

Wyer, his team manager David Yorke and several of the J. W. Automotive Engineering mechanics. John Wyer had been approached at the time of the 917's unveiling about the possibility of his taking over the operation of a works-backed team in 1970 and 1971 to replace his aging Ford GT 40s. The first visible evidence of the new tie-up was to be seen during the Austrian test program, when Wyer's men discovered that the 917's main problem centered not, as was thought, on suspension performance, but on aerodynamics. Some makeshift body changes were made with the aid of sheets of aluminum and tin snips, and as a result the car's high speed stability was greatly improved.



For 1970 Wyer's team, backed by Gulf Oil and run in its pale blue and orange colors, ran in tandem with a second factory-supported team under the aegis of Porsche Salzburg, and a considerable rivalry built up between the two teams, which perhaps helped to keep them both on their toes. But the Gulf-Porsches were to prove easily the more successful, Pedro Rodriguez and Leo Kinnunen sharing the winning 917 at Daytona, Brands Hatch, Monza and Watkins Glen, and Jo Siffert and Brian Redman at Spa and Zeltweg (as well as in the Targa Florio, where they used a lightweight 908/3 Porsche which was considered to be more suitable than the 917 for the road circuit).

There were two basic 917s in use in 1970, the 917K *(Kurz)* with short-tailed bodywork, and the 917L (*Lang*) with the long-tail treatment. It was only on the very fast circuits that the long-tailed cars showed any advantage, because although they were undoubtedly faster in a straight line, they could not match the handling qualities of the short-tailed car. In view of their drivers' preference for the 917K the Wyer team experimented with the aerodynamics of this version. By attaching an airfoil between the two side-boxes over the rear wheels and mounting small spoilers on top of the boxes they were able to reduce the drag factor without materially affecting the car's handling qualities. The result was that it was far less tiring for drivers to set a given lap time with the 917K than it was with the 917L, even though the latter car was some eight-mph faster down the Mulsanne Straight (220 mph instead of 212 mph).

But Le Mans was the one race in 1970 when everything went wrong for the Gulf-Porsches, Rodriguez retiring with a broken fan drive, Hailwood crashing the third car during a rainstorm, and Siffert missing a gear and over-revving his engine when firmly in the lead. In the end it was Richard Attwood and Hans Herrmann of the Porsche Salzburg team who finally gave the factory its long-sought Le Mans victory with a short-tailed 917 with 4.5-liter engine. Most of the other 917s were running the newer 87 mm x 70 mm 4907-cc engine, which had first been seen in the Monza 1000 Kilometers race two months earlier, and which was producing anything from 560 to 590 bhp at 8400 rpm.

The larger engine, produced to combat the 590 bhp which the Ferrari 12-cylinder engine was reputedly delivering, proved more than able to see off any opposition mounted against it during 1970, and it was also very reliable so long as it was not revved above 9000 rpm. The main effort during the following winter, therefore, was directed at increasing the usable rev band, more as an assurance against over-revving than as a means of extracting even more power from the engine.

For 1971, the Gulf-Porsches have been operating in tandem with the Martini-entered cars, following the withdrawal of the Porsche Salzburg team, although the change has been mainly in name, for the cars and the personnel involved have been very familiar. The 917 has won eight out of eleven championship events in which it has started, with Rodriguez and Oliver sharing the winning car at Daytona, Monza and Spa, Rodriguez and Attwood at Zeltweg, and Siffert and Bell at Buenos Aires, all for Gulf-Porsche, with Le Mans again proving the team's Achilles heel. On this occasion Rodriguez/Oliver and Siffert/Bell, both driving 917Ls with new tail treatment incorporating full width spoilers between tail fins and semi-enclosed rear wheels, dropped out with major oil leaks. Both cars had been delayed earlier by rear suspension trouble attributed to the extra downforce imposed by the revised body. Attwood and Muller in the team's 917K could only manage second place, following a gearbox problem, behind the winning Martini 917K of Gijs van Lennep and Dr. Helmut Marko.

So the 917 won its second Le Mans race for Porsche, and for the second year running the 12-cylinder car had contributed the major role in securing for Porsche the Manufacturers Championship. Its reliability record in perhaps the most demanding form of motor racing had been remarkably good—a tribute both to the basic design and to the quality of workmanship which went into the construction and subsequent maintenance of the works-supported cars. Thoughtful details such as the pressurization of the chassis tubes so that cracks could be identified by pressure loss before they became serious are typical of the way in which Porsche and its associates have minimized the chances of mechanical failure in their cars, and despite its early problems the 917 subsequently has proved to be a relatively simple car to maintain and to race-prepare.

That it was able to dominate endurance racing so completely was perhaps a pity, because the lack of sustained effective competition certainly detracted from the spectacle of this class of racing during 1970 and 1971. Nevertheless, the fault was not Porsche's; they had merely read the Sportscar regulations with great care, analyzed them and the potential they offered for a new type of car, drawn the correct conclusions, and gone ahead to design and build 25 race winners. It had cost them a great deal of money, but no doubt they felt it was all worthwhile. After all, as hinted earlier in this story, the full payoff from the 917 success story may not be felt for several years. □

PORSCHE 917 the inside story

How one of the world's greatest racing cars was developed — by the man who headed the design team

The Porsche 917 is without any doubt one of the most spectacular racing cars of all time, ranking almost equal for sheer drama with that pre-war Porsche design, the 16-cylinder Auto Union Grand Prix car of the 1934-37 era. In fact, the 917 sports car is more powerful than the Grand Prix car, having 630 bhp compared with the 520 bhp of the 6-litre Grand Prix unit.

Introduced at the 1969 Geneva Show, the 917 made its first racing appearance in the Nurburgring 1000 Km and won its first race, the Austrian GP at Zeltweg, at the end of that season. From then on it has been the car to beat, winning Le Mans in 1970 and 1971 and contributing greatly to the Constructors' Championship won by Porsche in both years.

A change in the regulations has eliminated the 917s from sports car racing in 1972, but a turbo-supercharged open version will take part in Can-Am racing.

A week or so ago Hans Mezger, the 35-year-old chief engineer, racing car design, of Porsche, presented a paper to an ordinary meeting in Birmingham of the Automobile Division of the Institution of Mechanical Engineers, in which he related the development story of the Porsche Type 917 for which he was responsible. Lack of space prevents us from reprinting this fascinating paper in full, but here are most of the highlights. **PAT**

The 917 is powered by an air-cooled 12-cylinder engine with twin overhead camshafts for each cylinder bank, two valves per cylinder and two plugs per cylinder. The original 4.5-litre (274 cu.in.) version had a bore of 85mm, a stroke of 66mm and developed 565 bhp DIN at 8400 rpm. For the 4.9-litre version used for the first time in the 1970 Monza 1000 kilometres, the bore was increased to 86mm and the stroke to 70.4mm. Power output went up to 600 bhp DIN at 8300 rpm. Finally, a 5-litre version was developed and made its debut in the 1971 BOAC 1000 kilometres at Brands Hatch. With a bore of 86.8mm and a stroke of 70.4mm, it developed about 630 bhp.

All cast engine parts with the exception of the cylinder heads are made from a magnesium alloy, RZ5, which, although suitable only for sand casting, has a high heat resistance and a good tensile strength. Weight of the complete engine is 240 kg (528lb.). The magnesium alloy parts weigh 156lb, 29.5 per cent of the total engine weight.

The most spectacular design feature of the engine is its central drive, power being taken via a pinion at the centre of the crankshaft to the gearbox via a layshaft. There is no doubt that the more complex design of the central drive engine has been worth while, for all difficulties caused by the natural vibration of the crankshaft — difficulties which increase with the length of the crankshaft — have thereby been avoided. The vibration characteristics of the 31.3in. long crankshaft are such that there is a vibration node at the centre of the shaft, thereby ensuring that no torsional vibrations occur at the centre drive pinion which also drives the four camshafts, the twin ignition distributors and the horizontal cooling blower. The centre drive pinion in fact drives two layshafts, a lower one to the clutch and gearbox, which also drives the main oil pump via a pinion screwed to the front of the layshaft, and an upper layshaft which drives the two ignition distributors, the alternator and, via two bevel gears, the cooling blower. The camshafts are driven from the centre pinion by five gear wheels.

The valves are actuated by cup shaped cam followers. In our experience, said Herr Mezger, the valve gear of the 917 could almost be called an optimum solution, as it incorporated a vibration-free drive from the crankshaft, a rigid power transmission via spur gears and no flexibility in the valve actuation gear thanks to the cup shaped cam followers. Both intake and exhaust valves were sodium filled, the intake valves having a head diameter of 47.5mm and being located at an angle of 30 deg. to the cylinder line. The exhaust valves had a head diameter of 40.5mm inclined at 35 deg. Titanium intake valves have been used experimentally, but at present have reached a stage which permits their use only for short races.

Previous Porsche six cylinder and eight cylinder engines all have only one connecting rod per crankpin, but the 917 has two connecting rods per crankpin. This arrangement resulted in a shorter overall length of the engine which has only six crankpins and eight main bearings — two in the centre — instead of 12 crankpins and 14 main bearings. The smaller number of bearings reduced the frictional losses and enabled the width of the main and connecting rod bearings to be increased with consequently improved lubrication.

The oil circuit is an important feature of every high performance engine. It is one of the major factors both for engine stability, and for engine performance. On the one hand all bearings, pinions and cams need an adequate oil supply; on the other hand it is necessary to keep oil throughput at a minimum in order to avoid splashing losses. The dry sump lubrication system of the 917 engine includes seven oil pumps. The main oil pump located in the front of the crankcase consists of two scavenge pumps for the front and rear crankcase and a pressure pump which feeds oil into the crankshaft axially from both sides. Thanks to the employment of central drive both ends of the crankshaft are free, which has allowed the use of a more efficient lubrication system for the crank and connecting rod bearings running at a lower pressure and almost independent of engine speed. Four small scavenge pumps at the ends of the exhaust camshafts keep the camshaft housings as dry as possible.

The oil extracted by the six scavenge pumps is returned to the oil tank, but should the oil temperature rise above 85 deg. C, then a thermostat operates and diverts the oil through an oil cooler at the front of the car.

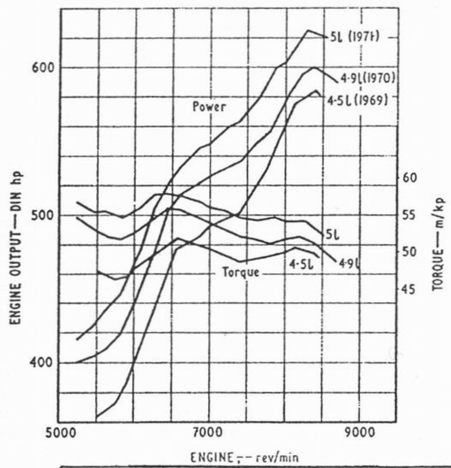
Bolts for joining the two halves of the vertically divided crankcase and the cylinder heads presented a problem as both titanium and steel bolts have a lower rate of expansion than magnesium and aluminium. Both crankcase and cylinder head bolts are therefore made of Dilavar, a special steel alloy with almost the same rate of expansion as magnesium and aluminium. Titanium was first used by Porsche 10 years ago for connecting rods. Now, all Porsche racing engines are fitted with titanium connecting rods, and only cost prevents their being fitted to production cars.

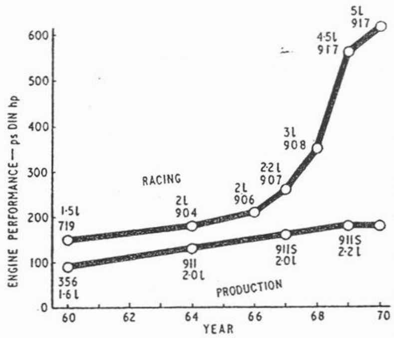
The individual cylinders are forged from an aluminium alloy, machined, then coated with a chrome sliding layer. These Cromal cylinders are used on all Porsche racing engines.

The individual cylinder heads are chilled in an iron mould from a heat resistant aluminium alloy and are the only aluminium castings on the engine.

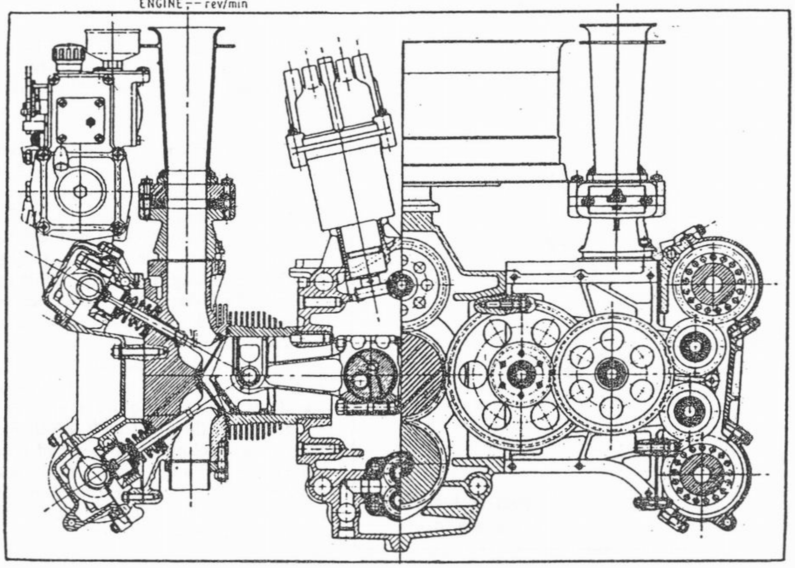
The combustion chamber follows Porsche production practice and is formed by the spherical cylinder head surface and the spherical shaped piston crown. The axes of the intake and exhaust valves intersect in the centre of the cylinder head sphere.

The fuel injection pump was developed specially for the engine, with a separate plunger for each cylinder arranged in two banks in a magnesium housing and actuated by cams. A three dimensional cam dependent on engine speed and throttle position controls the fuel volume. The cam is specially shaped to interrupt the fuel supply when the engine speed is more than 4000 rpm and the throttle slide is closed. This prevents fuel from accumulating above the slide when the car is entering a corner under braking and then pouring into the cylinders as soon as the throttle is opened again at the exit from the corner.





Left, output and torque figures for the 917 engine. Above, output of Porsche racing engines, and production engines. Below, a cross-section of the 917 engine. The right half shows a section at the centre drive—the left the position of the front ignition distributor and its drive via the layshaft



The cooling properties of the 917 engine are superior to all earlier Porsche air-cooled racing engines, for the 13in. dia. glass-fibre blower requires only 17 hp to drive at maximum engine power. This is only 2.7 per cent of the maximum power, whereas the blower for the 3-litre eight cylinder engine required 3.9 per cent of the maximum power, 360 bhp. Of the cooling air, 65 per cent is used to cool the cylinder heads and 35 per cent the cylinders.

A racing car which is often thought to be a car without compromise, is actually the ideal compromise — the most favourable combination of all pertinent factors such as weight, engine power, air resistance, lateral load, straight-line running, braking, fuel consumption and the minimum wear of tyres and brake pads. The driver's comfort is also important, for it is affected by the seating position, visibility, use of pedals, steering wheel and gear change and by the cockpit air conditioning.

Finally, the influence of a psychological aspect must not be forgotten. The real speed of a racing car is not primarily determined by the engine power nor by its wind resistance, but by the confidence placed in it by an experienced driver with a sense of responsibility, shown by the highest speed he dare attain without undue risk. The driver must feel that the car will not go out of control when pressed to the limit but will respond exactly to his wishes.

Porsche have invested a lot of time and effort in lightweight structures and in safety — there is a direct connection between the two. Research in these two directions has been pursued for years, with some success, and has secured for Porsche not only pre-eminence in the construction of extremely light racing and performance cars, but also vital knowledge.

Of course a lightweight structure is a genuine and justified improvement only if safety is not sacrificed. No new part which may fail or which could prejudice safety is fitted without prior testing.

The racing cars are subjected to an endurance shatter test on the Porsche testing grounds to try out the chassis and chassis parts under conditions of much higher stress than they will encounter on any racing circuit.

The engines are subjected to an 18-hour endurance bench test at full load, and the transmissions are tested on a specially devised race circuit simulation programme on the chassis dynamometer, programmed to include all the relevant gear changes, bursts of acceleration and brake applications.

In 1967 Porsche developed a space frame chassis with aluminium tubes for a light 2-litre car competing in the European Hill Climb Championship. Failure of the chassis was hardly to be expected for the distances of the various events were very short and the car had already been tested on the Porsche rough track. Nevertheless, the chassis was checked regularly, and to facilitate this testing for possible cracks all the tubes under load were interconnected by small holes and the whole frame then filled with compressed air. A crack in a frame tube would thus immediately be revealed by a sharp drop in the air pressure.

Early in 1968 a racing car using an aluminium space frame was entered for the Daytona 24 hours, in which it finished even though it had completed almost 30 hours of running at the track during practising before the race. In the light of this experience, it was decided to build the 917 frame of aluminium tubes. The frame, built up by shielded arc welding, weighs 104lb. (47 kg).

The 11 races for the 1971 manufacturers' championship were run on a wide variety of circuits. The 917 therefore had to be an all-rounder. The Nurburgring, for instance, requires no less than 6.7in. of wheel travel and very soft springs, which complicate the wheel kinematics. Half this travel is sufficient for Le Mans which requires harder springs as on this very fast circuit big variations of the attitude of the car on its springs will adversely affect its aerodynamic stability.

At Le Mans 66 per cent of the lap time is spent at maximum load and the car therefore needs excellent straight line running, but at the Ring the car spends 46 per cent of its lap time in cornering and only 39 per cent at high speed. An improvement of 10 per cent of the attainable cornering force (g) would reduce the lap time at the Ring to a value which could not be achieved even by doubling the engine power. At Le Mans, however, a 15 per cent increase in engine power will achieve the same result as a 10 per cent improvement in suspension.

The Porsche racing department also makes use of electronic data processing. A computer calculates the circuit lap times to be expected and determines the correct gear ratios for the various circuits.

The driving diagrams calculated by the computer have shown that during races the cars are cornered at speeds producing even higher transverse acceleration values than the 1.4 to 1.5g reached on the 600ft. circle of the Porsche skid pan. This is partly due to the body shape creating downward pressure at speed and thus increasing the wheel loading. The drag coefficient of the 917K which won the 1970 Le Mans race is approximately 0.46, with a coefficient of downward pressure of 0.019 at the front and 0.351 at the rear. It would be possible to develop a body shape with a drag coefficient below 0.3 which would give a top speed of much more than 250 mph for the 630 bhp of the 917. However, this would be of only theoretical importance for lack of stability would not permit the high speed to be realized, even on extremely fast circuits.

The body shape cannot be assessed only in terms of its drag coefficient — the aerodynamic stability is equally important. Test drives with a 917 on a circuit lapped at approximately 1m. 45s. showed that body modifications alone could improve the lap time by 3 or 4sec. This is a surprisingly large improvement which more than 50 additional bhp would be needed to equal.

The Le Mans circuit, however, is unlike any other circuit in that an increase in top speed, i.e. a reduction of the drag coefficient, makes a bigger contribution to improved lap times than greater cornering power. In 1970 a special 917 was built for Le Mans with a drag coefficient of only 0.360. The computer calculated a lap time of 3m. 19.3s. for this car, which during practice lapped in 3m. 19.8s. Theoretically the car should have won but heavy rain during the race caused tyre and ignition problems and it finished 2nd. However, while the winning 917 with its normal body averaged 6.23 mpg, the special bodied car averaged 7.3 mpg.

The development of a racing car is neither easier nor more difficult than that of a production car. There is, however, a difference in "engineering" of the two kinds of car owing to the different requirements they have to fulfil. It is impossible to define the ultimate purpose of automobile racing in one sentence — just as it is impossible to do so for the car in general. The statement "the car is a device for transporting persons from A to B" is incorrect or at least incomplete, for if that were all there is to the phenomenon "car", then the Rolls-Royce Silver Ghost could never have existed. One extreme is the pure transport vehicle, the other is the pure racing car. In between are the cars for people who want to get from A to B. Some of them want to travel comfortably, others swiftly and yet others both comfortably and quickly. And as a final comment, Herr Mezger added "In the case of a racing car not only the driving but also the designing is fun".

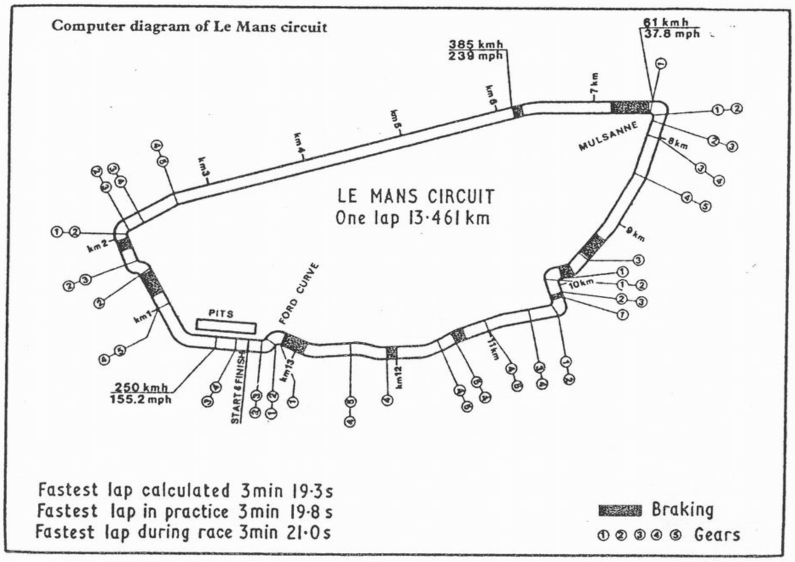
Opening the discussion that followed, John Wyer, who ran the JW-Gulf team of 917s, congratulated Porsche on producing one of the greatest racing cars in history. Wyer said it was much easier to improve the coefficient of drag than to increase the stability of a car, and went on to detail his team's development work on the short tail 917. By flattening the ramps over the rear wheels until they were horizontal, the drag coefficient was improved from 0.47 to 0.371 but the lift coefficient became a problem when the car yawed 10 deg. from the straight ahead position. This was cured by adding an aerofoil at the tail between the ramps and downsweeping the floor of the valley between the ramps.

Wyer commented that the 1970 long tailed Le Mans 917 had not been very stable and was less than 1s. a lap faster than the normal short tail cars, but the 1971 long tailed 917 was very stable. The drivers told him they could move the car right across the road at 238 mph without embarrassment.

In answer to further questions, Hans Mezger said they had tried carbon fibre reinforcement for the glass fibre body of a Le Mans car. The cost of designing the 917 had been very low as they did not have very much time to spend on it. However, this made the development period very expensive for they were ordering parts in titanium, magnesium and steel at the same time to try one against the other. Porsche reckoned to spend 2-3 per cent of their revenue from sales on racing. This amounted to about 12 million marks £1.45 million.

Asked why they had retained tubular frame in preference to monocoque construction, Mezger said it was much easier to modify and develop a tubular frame than a monocoque, as individual tubes could be taken out or added should suspension modifications be required. He also held they could make a lighter and stiffer frame from tubes than with a monocoque. He did not think safety had been reduced by adhering to a tubular frame.

Asked whether Porsche had remained faithful to air cooling for the 917 because all their production cars were air cooled, Mezger said they had made the 917 engine an air cooled unit because of their excellent experience with air cooled racing and production engines. Air cooling was difficult, however, if four valves per cylinder were required, for there was then not sufficient room for the air to circulate round the cylinder head. As the 12 cylinder engine did not run at very high engine speeds it did not require four valves per cylinder, but they had built a 3-litre engine with water cooling when they had tried four valves per cylinder for it. They had also developed normal water cooled production engines — many of his listeners wondered for whom that was done. ■



Computer diagram of Le Mans circuit

Porsche Car Clubs

Porsche Club GB
Roy Gillham,
Ayrton House,
West End,
Northleach,
Gloucs. GL54 3HG

Porsche Club Deutschland
Manfred Pfeiffer,
Podbielskiallee 25-27,
D-1000 Berlin 33,
West Germany

Porsche Club of America
Sandi Misura,
1753 Las Gallina,
San Rafael,
California 94903,
USA

Porsche Club of Finland
Klaus Kingelin,
Sipilan Kartano,
SF-12380 Lappakoski,
Finland

Porsche Club of Western Australia
Rob Jones,
PO Box 447,
South Perth,
Western Australia 6151,
Australia

Porsche Club Denmark
Flemming L Nielsem,
Ved Jaegerdiget 9A,
DK-2670 Greye Strand,
Denmark

Porsche Club of N.S.W.
John Clark,
PO Box 183,
Lindfield,
N.S.W. 2070,
Australia

Porsche Club South Africa
Angela Hauser,
PO Box 9834,
Johannesburg 2000,
South Africa

Porsche 917

4.5 Litre Engine of
1969 917 Group 4 Sports-Cars,
1969 917 PA Can-Am Cars
And Early 1970 917K Group 5 Cars

Engine Construction:	Split crankcase of magnesium alloy, Individual forged cromal cylinder barrels, Cast aluminium cylinder heads, 2-piece chrome-nickel crankshaft, Forged titanium connecting rods, Forged aluminium pistons. Engine weight 528 pounds.
Bore and Stroke:	85 mm x 66 mm, 4,494 cc
Valve Operation:	Double overhead camshafts per bank, Gear driven from centre of engine, Cylindrical cam followers, Sodium-filled valves, 1 intake and 1 exhaust per cylinder.
Intake Valve Diameter:	47.5 millimetres
Exhaust Valve Diameter:	40.5 millimetres
Compression Ratio:	10.5 to 1

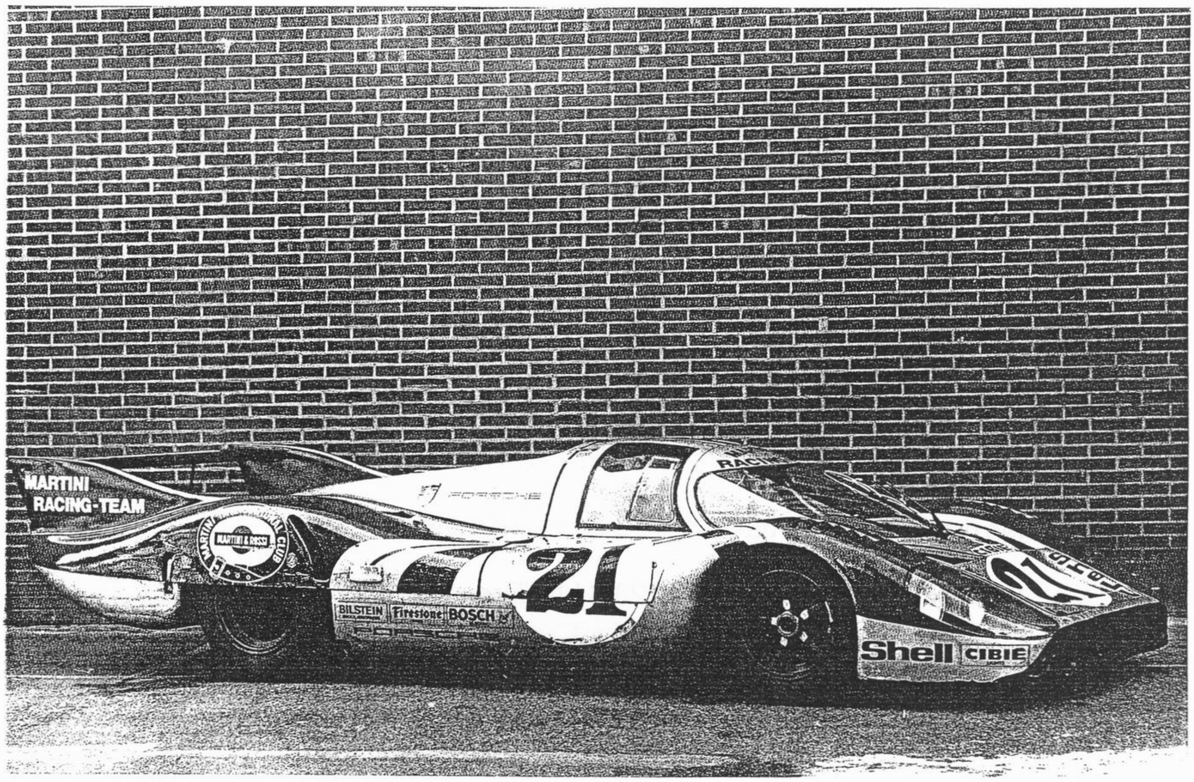
	Maximum Power Output	Specific Output	Maximum Torque
1969 Group 4	520bhp @ 8000rpm	115.7 bhp/litre	336 lb ft @ 6800rpm
1969 Can-Am	580bhp @ 8500rpm	129.0 bhp/litre	376 lb ft @ 6800rpm
Early-1970 Group 5	540bhp @ 8400rpm	120.3 bhp/litre	361 lb ft @ 6600rpm

Electrical System:	12v 50 Ah. Alternator and two distributors driven from upper layshaft, Two Bosch x 290 P1 spark plugs per cylinder. Firing order 1-9-5-12-3-8-6-10-2-7-4-11
Cooling System:	Air-cooled by thirteen-inch diameter fibre-glass fan, horizontally located above engine and gear-driven from upper layshaft.

Porsche 917

General Specifications

Frame:	Aluminium multi-tube space frame with 20mm, 25mm and 32mm diameter tubing.
Steering:	Rack and Pinion, with 2 turns lock to lock.
Front Suspension:	Independent by unequal-length upper and lower arms, Radius struts, Titanium coil springs, Adjustable anti-roll bar.
Rear Suspension:	Independent by unequal-length upper and lower arms, Longitudinal control arms, Titanium coil springs, Adjustable anti-roll bar.
Brakes:	Twin-circuit ATE and later Girling hydraulic 12 x 2.06 inch radially-vented discs with 4-piston callipers. Lateral venting added to discs in 1971.



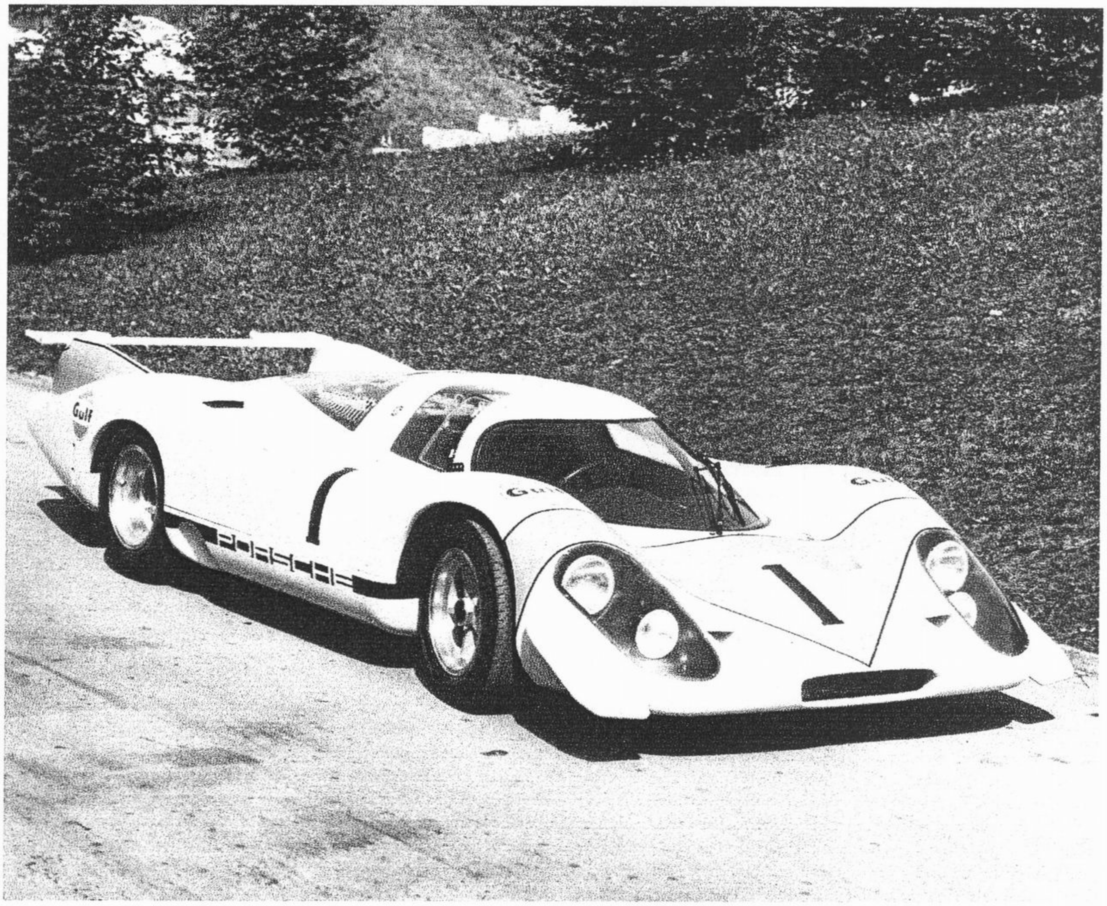
Porsche 917
Gearbox and Final Drive

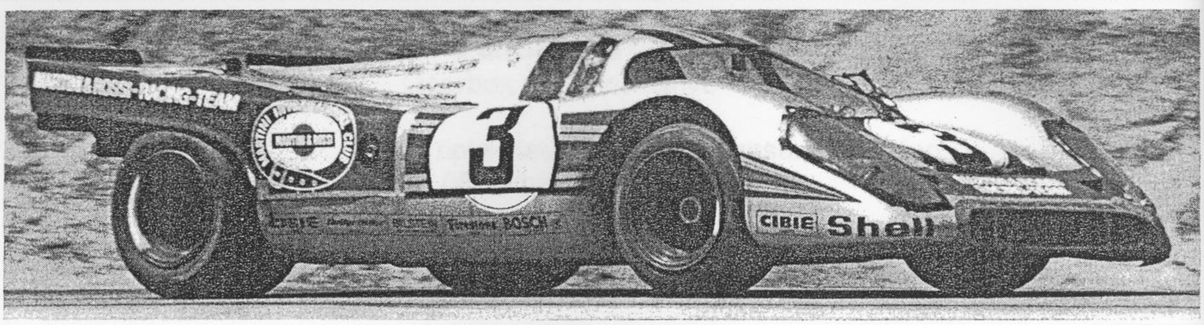
Clutch:	Triple-plate dry, inside transaxle housing. 7.08 inches in diameter.	
Transaxle:	Cast magnesium casings bolted to back of crankcase.	
Gearbox:	4-speed or 5-speed and reverse with Porsche ring synchronisation on forward speeds.	
Final Drive:	Spiral bevel ring and pinion gears, Limited-slip differential with 75 per cent blocking. Final Drive Ratios: 4.428, 4.444, 4.625, 5.285 and 5.375 to 1.	
Drive Shafts:	Titanium, double universal-jointed.	
	4.9 Litre Engine of 1970-1971 917K and 917LH Group 5 and 1971 917 Interserie	5.0 Litre Engine of Late-1971 917K Group 5 Car and 1971 917 Interserie and 1971 917/10 Can-Am
Bore and Stroke:	86mm x 70.4mm (4,907cc)	86.8mm x 70.4mm (4,999cc)
Maximum Power Output:	600bhp @ 8400rpm	630bhp @ 8300rpm
Specific Output:	122.2 bhp/litre	126.0 bhp/litre
Maximum Torque:	405 lb ft @ 6500bhp	427 lb ft @ 6400bhp

Porsche 917 5.4 Litre Engine Of 1972 917/10 Interserie and Can-Am

Bore and Stroke:	90mm x 70.4mm (5,379cc)
Maximum Power Output:	665 bhp @ 8300 rpm
Specific Output:	123.6 bhp/litre
Maximum Torque:	450 lb ft @ 6500 rpm

Porsche 917



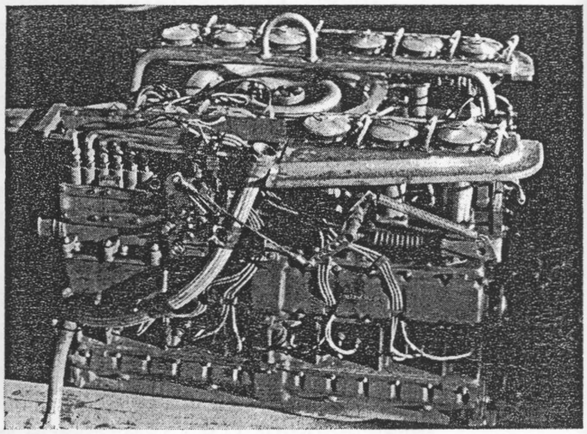


The Martini & Rossi 917 won the 1971 Sebring 12-Hours.

DON BOK PHOTO

PORSCHE'S MARVELOUS MONSTER

When it was new, the 917 was impossible to drive. Now that it's old, it's nearly impossible to beat.



Flat-12 engine is as complicated as it looks.

THE LAWS OF NATURE determine the movements of the heavens, but the shape of international endurance racing is controlled by the elderly gentlemen of the Federation Internationale de l'Automobile. They are a lot more mutable than Mother N., and as one pressure after another pulses down the halls of Paris they react by changing their ideas about our sport. Thus the cars on the circuits change from year to year, and some years are consequently more vintage than others. The anthologies of the future will count the Porsche 917 as one of the more memorable designs. They may not necessarily call it a great automobile, but they will recognize that it has proved itself *the* successful solution to a problem—the problem imposed on long-distance sports car racing by the FIA's Appendix J, Group 5 rules for the period 1969-1971.

To simplify the background, through 1967 the big endurance car, usually thought of as The Le Mans Car, had no engine limitations. This was the era of the Ford GT40, the Mk II version which won Le Mans in '66, the Mk IV that won the following year, and the 2D and 2F Chaparrals that had victories at Nürburgring and Brands Hatch respectively. The American machines, in other words (French-accented words) were going entirely too fast and something would have to be done. For 1968 big sports cars were cut back to 5 liters of engine, "engine" being generally accepted to imply cheap American stock-blocks, with the proviso that 50 complete cars would have to be presented to qualify for homologation. A team could take another approach by building no more than they wanted to of lighter machines using 3-liter engines. Both Ford-USA and Chaparral immediately withdrew from the European scene, leaving the races to the two "lightweight" types. During that first year, although the by-now-aging GT40 won Le Mans, the two were pretty closely matched. The same situation continued into 1969—even to the GT40 win at Le Mans—but the background was changing. The FIA, in response to pressure from England (Surrey accents), reduced the quantity requirement for homologation into Group 5 from 50 to 25.

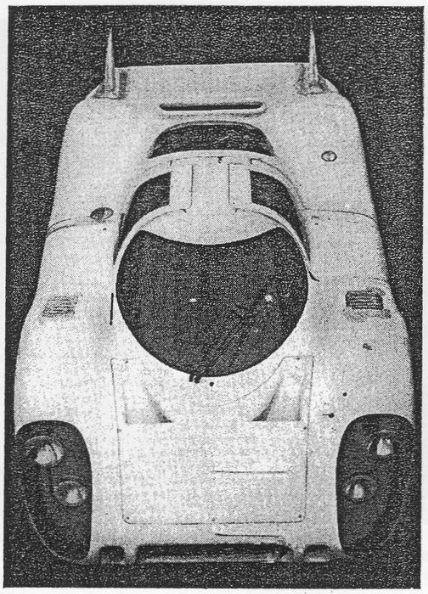
Porsche caught on quickly. The Directors must have looked at each other with wild surmise and said, look, for very little extra expense we could produce the full 25 examples; to get the larger engine we will simply multiply our 8-cyl engine by 1.5 and have a 12-cyl 4.5-liter. *Wunderbar!*, they must have said (in Swabian accents, of course).

So, through a loophole in the paddock fence, the 917 appeared. The new big Porsche was expected to effortlessly sweep all other cars into its maw as casual snacks and in a race or two would go hungry looking for opposition.

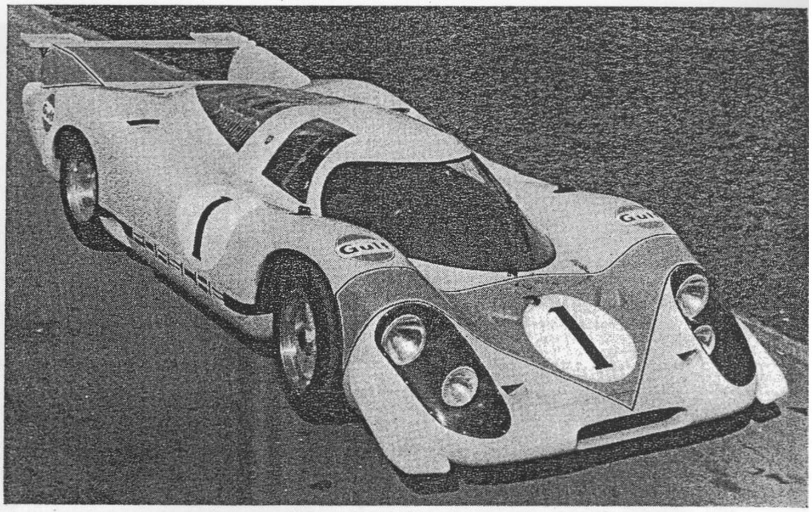
But it didn't quite happen like that, not at first. The press release photograph of 25 cars lined up for homologation inspection remained their only public appearance and rumors began to flicker out of the German forests. Terrible rumors, of Instability, and Uncontrollability, and Fear.

What had Porsche wrought? At a reported cost of nearly $1.25 million, and in a mere 10 months from surmise to press photograph, they had fashioned a flat-opposed 12, air-cooled, in an aluminum-tube chassis, suspended on modern Grand Prix geometry, wrapped tightly in a teardrop coupé shell. The driver perched up between the front wheels. He had 560 horsepower to control and could go 230 mph. If he dared. It was a machine built in haste, with minimal experimentation beforehand, and all 25 examples embodied the same mistakes. They were next to undrivable.

Sitting still, it was a magnificent piece of work. It was literally built around its enormous engine, 600-plus pounds of engine, over 30 inches long and 30 inches wide and almost »



The original body was sleek but unstable.



Fore and aft fins transformed the 917 into a winner.

PORSCHE'S MARVELOUS MONSTER

26 inches deep counting the injectors. It was cooled by a blower that drew in, at designed optimum rpm, 2400 liters of air each second. (When Gulf Research in Pittsburgh agreed to carry out development on the engine, they ended by having to build a separate little building for the dynamometer. The 917 would evacuate nearly all the air in their normal dyno rooms.)

The backbone of the engine was the long crankshaft—chrome-nickel steel, six journals, eight main bearings, the drive for everything taken from a pinion in the center because the center of its length was the point of minimum vibration. The drive to the camshafts was by a train of pinion gears out each side, and a long layshaft on top drove the blower and both distributors (twin plugs per cylinder). The drive to the clutch went out another shaft living in the bottom of the sump. Oil was fed in at either end of the crankshaft, axially, which because of not having to fight centrifugal force enabled a healthy reduction in operating oil pressure.

There were seven oil pumps!—a pressure and two scavenge units in the crankcase, and one evacuating each of the four cam boxes. Oil use by the valve gear was cut nearly by two-thirds by the cunning use of metering holes that were uncovered by the tappets only when they needed lubrication. Oil circulated through certain of the frame tubes and when its temperature exceeded 85° C a thermostat routed it to a cooler in the nose.

Bore and stroke of the first engines were 85.0 x 66.0 millimeters; later the displacement was taken out to 4910 cc by using 86.0 x 70.4 (3.38 x 2.77 inches). The connecting rods, two per journal, were titanium, and so were the big-end bolts. There were two valves for each generously hemispherical combustion chamber, at an included angle of 65 degrees. Dual plugs were adopted to get a good flame pattern. Compression ratio was given at 10.5:1. The cylinders were of aluminum, the bores being plated with chromium and then minute oil-retention pits rolled in. The heads were individual to each cylinder, held on by long through-bolts to the crankcase. These bolts were of a steel called Dilavar, which has nearly the same expansion rate as the aluminum and magnesium they held together.

This marvelous monster nestled in a space frame of aluminum tubing which, with all the members that supported the body, weighed 104 lb. The body was glued to these members, thus contributing to overall stiffness (if greatly complicating the job of body repair or replacement). As on the 908, there was a nipple let into a frame tube so the entire structure could be pressurized; a certain pressure drop over a certain period meant the mechanics would have to start looking for cracks. The suspension links were of aluminum tubing, while there was as much use as possible of titanium in hubs, steering, halfshafts, etc. Even the road springs were Ti, the wire being ground conically so that the small end compressed first and provided progressive spring rates.

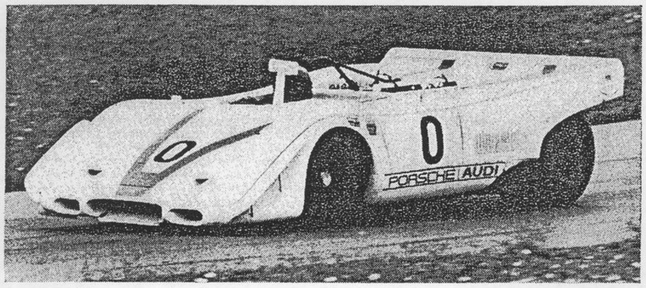
The original design had pivoting flaps at each corner of the body, linked to the suspension in a way intended to react aerodynamically against the chassis' motion over the road surface. Even as the car appeared, however, such devices were banned by the FIA; there was a big back-room drama to get them allowed on the 917 for 1969.

The wheelbase was short at 90.4 in.; the front track was 58.6 while the rear, on the original 12-in.-wide rear rims, was 57.4; the rear wheels were later changed to 17-inchers. The original body width was 74 in. and it was a mere 36.2 in. high. The weight as usually given is the same as the minimum for the class, 800 kg or 1760 lb, but a practical everyday figure would be closer to or even over 2000, even without much or any of the 36 gallons of fuel allowed.

Porsche brought the car out to race now and again during the summer but it was always so unstable at high speed, so ready to veer off the road, that there was not a long line of drivers eager to strap themselves into it. A couple machines (at least) were destroyed in testing and on the first lap of Le Mans the English privateer John Wolfe crashed fatally.

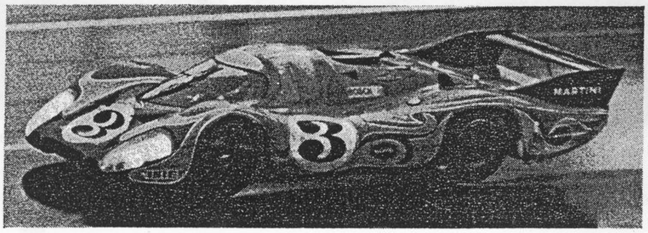
At the same time, two extra chassis were run off as open cars and one was taken to America where it contested the '69 Can-Am season. At Michigan it demonstrated its basic toughness by doing the second part of the race and finishing 4th behind three factory McLarens without any benefit of its cooling blower. It was, however, as anyone who saw it even once will recall with a shudder, maniacally unstable.

For the '70 season, Porsche decided to farm out its racing activities and entered into an agreement with the English firm that had so often beaten them with Fords, John Wyer Automotive. Under the generous sponsorship of Gulf Oil,



The ungainly Spyder ran in the 1969 Can-Am.

Batmobile tail, for reduced drag, at Le Mans, 1970.



GEOFFREY GODDARD PHOTO

PETE LYONS PHOTO

For Watkins Glen 1970, the downforce tail.

JW took over seven chassis, which they tested, modified and prepared, usually selecting two machines plus a training car to go to a given race. Concurrently, three cars were supplied to Porsche of Austria, the management of which was related by marriage to the Stuttgart management.

In the autumn of '69, JW participated in some tests at Zeltweg in Austria. It was apparent to them that the shape of the body was not doing the work required from it. On the spot they built up a modified tail section with a wedge profile. The results were dramatic. Pedro Rodriguez recalls that, "It was a completely different car, it was beautiful, it was perfect. I was five seconds faster immediately."

Thus encouraged, JW and the Austrian team had completely new bodies made up with wider, more wedge-like nose shells and a rising, flat tail section. (The pivoting flaps were eliminated at the same time.) The ultimate top speed was cut rather drastically from 230-plus to less than 210, but the lap times, which are what it is all about, went down spectacularly. Suddenly the pariah became the one seat coveted by every sports car driver on any entry list.

What the new body did was generate aerodynamic loadings onto the rear tires. As a tire's load is increased vertically, so does it increase its ability to carry lateral loads. Its cornering power is increased, in other words.

Rejuvenated by its facelift, and with a lot of minor problems fixed (such as a new gearbox), the 917 romped through the '70 endurance races, winning all but one of the events it was expected to win, including Le Mans. The only head-to-head opposition came from the Ferrari 512S, which was as capable of turning good lap times but suffered as had the Porsche the year before from being a brand new machine.

In 1972 the FIA will eliminate the present G5 category completely, and there will be no more 5-liter cars. The point proved, Porsche turned down the burner under the 917 development and 1971 is being run with last year's cars only slightly altered. Ferrari has done the same, as both firms concentrate on their 3-liter designs. Already, the latest little cars are challenging the static big ones. But they cannot detract from the glamor that always has and always will surround the *biggest* race car. From some reference points the 917 (and the 512) is a nimble little scrapper; from others it is a big long-range bruiser, already a little heavy and sluggish but still putting out punches no one can ever forget. It will live in our books as an important car, as significant to our emotions (for, let's face it, our involvement with these cars is purely emotional) as other high points among its long line of predecessors: the GT40s, the Chaparrals, the big Ferraris, Masers, Mercs and Jags. Not the little, quietly efficient ones. The big loud *fast* ones.

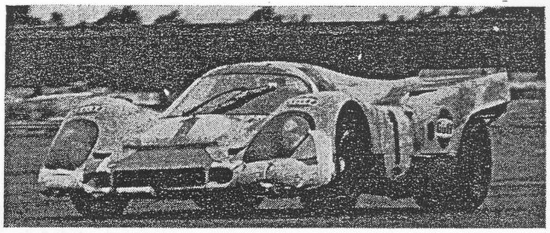
So let's flesh out the cold metal a little, help it live in our minds. What, as Chris Economaki should have asked Pete Hamilton, is it like in there?

The enthusiast who finagles a garage pass and talks someone into letting him sit in a 917 will immediately be struck by how much he feels crammed up in the nose between the wheels and sharing space with tubes and steering and pipes and coolers. The glass canopy bends very closely around his head, and the front fenders, while not really high, are very prominent. His legs are canted off at an angle to the center of the car; in fact his left foot is over in the "passenger's" side. The actual seating position is very comfortable, as it must be in any vehicle which requires that absolutely nothing distract the driver's concentration from his driving. Every control is conveniently near, and he will be thinking, as the kindly man standing there begins to fidget, that really he would rather not get out.

But most of us (until these cars begin to come on the aftermarket and get muffled for the street!) will go further only by sitting at the feet of the drivers, begging them for their experiences. There's Pedro, for instance.

Rodriguez says, "I find that the 917 is one of the nicest cars that I have ever driven. It is very *easy* to drive. The gearbox is as nice as the 911 private car—and I think that this makes you probably easier *on the car* when you drive it. On the contrary, The Ferraris and other cars are hard, strong cars, you must work on them, on the gearbox and the brakes. The Porsche makes you very comfortable.

"I think that the Ferrari is more powerful, but the Porsche has very good torque low down. It will actually pull from 4000. With the Ferrari that I drove two times last year you *must* keep the revs above 6000. At Daytona, I noticed that when I was with the Ferrari of Donohue and he changed gears he would pull away a little bit from me. I had only a 4-speed gearbox, and when I changed from 3rd to 4th I



Twenty-four hours of hand-to-hand combat at Daytona left their mark, but the 917 grinds on toward another championship.

The 917 slouch, as demonstrated by Jo Siffert. Comfortable, and the hand falls readily to gearshift.

would lose 2500 revs, and the engine did not go immediately back to 8000. For Sebring we are using 5 speeds. Except for that, I thought the Porsche and Ferrari were exactly the same. The best engine we had in 1970 was 590 horsepower. This year in Argentina we had 605 and the factory promises us we can have 640 in the middle of this year.

"The brakes are one thing that I think have not really been *very* good, because if you try really very hard, the car becomes unstable.

"And in the 917 when you fly over a jump,—Wh-o-o-o-w! But I like to drive it on fast circuits. I like very fast cars. I think perhaps next year I won't enjoy to drive only little cars."

Jackie Oliver: "The car is a little difficult to drive at first, because you sit so far forward. All the feeling you get through the seat of your pants has got to be re-digested in view of the fact you're sitting two feet farther forward. It's a little strange but 30 laps or so and you get used to it. It's a very easy car to drive. It's a fabulous sports car because it's like a 2-liter car, not in regard to the power from the engine but in the way the car handles. It's very quick. It's very comfortable, has a super driving position, and it's not too hot.

"The car is very good in a fast corner. It doesn't like hairpins very much; they make it understeer. I think it's something inherent, due to the size and weight of the car. You go into a hairpin and you're on light throttle and the car is understeering slightly and you think, Christ, this is going to take forever and an age. So you give it a bootful to try to speed things up. But it understeers more and you have to back off to get it back on line. Next time you think, oh, this is no good, so you give it a big flick. Well maybe once in 50 times you get some oversteer in, and you get it spot on and it all goes around lovely and you've got the power on. The other 49 times it's either too much and you spin, or it's not enough and you're back on the understeer again, or you frighten yourself, or you make a big hooley of it and you correct too early. So there's only one way to go around a hairpin and that's as tidy as possible, as much as the car will allow, with just a little bit of understeer, and when you see the exit, *plant* it.

"The engine pulls well from about 6000. It gets a high-pitched vibration that's rather coarse on the seat of your pants over 8000, because that's when the power all comes in. It pulls quite strong then; there's a step in the curve. It's got characteristics like a Can-Am engine, but with race-bred thoroughness and response to boot."

Vic Elford: "I think of all the drivers, only Stommelen and myself were keen on persevering with the car in 1969. The early 917 really was virtually undrivable, you know. But we all put a lot of work into it and eventually the car was transformed. It is extremely sensitive to minute alterations; you can change the ride height by as little as one quarter of an inch at the front, for instance, and feel a great difference. I lost a side window at Daytona. It fell out and I didn't notice until I began to feel warm; it made that much difference to the airflow.

"The brakes are quite fantastic. You can use them really hard before you start to lose stability. You can wait to put them on longer than you can believe. I think actually you could brake later than the Ferrari—but you'd have to be awfully brave to prove it!

"It's sometimes difficult to arrive at a balance between oversteer and understeer. The car is at its best in medium speed turns or on ultra fast tracks. At Monza, for instance, it's perfect. It's good on circuits like Brands Hatch as well, but the Nürburgring is bloody hard work for it. In tight corners it is a difficult car, but if there is plenty of room you can toss it through. It's rather a heavy car; that shows up in the rain especially. You have to catch it quickly if it's not to get away from you. It's very controllable in the wet, however; you can get it to quite incredible angles.

"I've driven it in long-tail form at Le Mans, you know. It will go 236 miles-an-hour, and I'm absolutely convinced that is a genuine figure. At above the 200 mark it becomes unstable in corners, but at Le Mans there are only a couple of those bends. On the Mulsanne straight there is a kink down toward the end and the car takes that well enough, but right after that you crest a sort of little rise and there you get a very tippy-toes feeling indeed. You're quite sure that the car is right on the point of actually flying.

"I've driven many fast cars, but the Porsche gives me a tremendous sensation of speed. You're sitting down right close to the road, and you're all closed in, and you can't see very well. . ."

So it's a car that impresses its drivers. They speak of it with a slight undercurrent of awe and one feels they will remember it for a long time. It's not a sweet, all-around sort of car with forgiving manners. It has lots of character. Its good qualities have to be accepted with less good. It is not the sort of car (say some of the drivers after one has promised not to quote them directly) that one would like to have an accident in; you feel too exposed in it. On rough surfaces one can feel the chassis flexing, doing some of the suspension's work. There are not many privately owned 917s.

But it is a thoroughly engaging car. It looks nice, hunched and sleek and eager. It sounds nice with its liquid hum. At the first light of day at Daytona, when the car gradually takes shape around its intense quartz driving lights, you can see the battle wounds of the night, the cracks and strips of tape, the streaks of filth on its long flanks. The machine has been hustling around for 18 hours, and it has another six to go, and it is battered and torn, but its multicamshaft heart still cries its splendid defiance. It *is* a car you'll remember.

THE DEVELOPMENT OF THE PORSCHE TYPE 917 CAR

For approximately twenty years Porsche has participated in motor racing. The development of Porsche production cars takes advantage of a major part of the experience accumulated during these performance-oriented activities.

This paper deals with the development of the Porsche 917 racing car which is powered by an air-cooled 12-cylinder engine producing about 630 DIN hp. The application of lightweight materials like titanium, aluminium, magnesium, fibreglass, etc. is also described.

The Porsche 917 racing car which obtained its Fédération Internationale de l'Automobile homologation by a series of 25 in April 1969 has now become the most successful car in motor racing throughout the world. In 1970 the 917 car was the overall winner at the 24 hours race at Le Mans.

1 INTRODUCTION

In 1968 Porsche decided to develop a sports racing car incorporating a 4·5 litre (274 in^3) 12-cylinder engine. At that time regulations only permitted the prototype sports car up to 3 litre (183 in^3) or so-called 'series sports cars' up to 5 litre (305 in^3) as a maximum. Prototypes were not subject to weight limits nor production figures. The 5 litre sports cars, however, required a minimum weight of 800 kg, exclusive of petrol, and a minimum production of 25 cars.

When the 917 project became known experts said that an air-cooled engine of this size was not feasible, but the development of the 917 proved the critics to be wrong.

In 1969 Porsche demonstrated twenty-five 917 sports racing cars to the international committee of the Fédération Internationale de l'Automobile (F.I.A.). Thus the 917 was approved and admitted to world championship racing events after ten months of development, construction and testing.

We now know that the cooling properties of the 917 12-cylinder engine are superior to all of Porsche's earlier air-cooled racing engines. This holds for the engine temperatures as well as for the power requirements of the cooling air blower drive. For instance, the power required by the blower of a 3 litre 8-cylinder engine was 14 hp at an engine performance of 360 hp, i.e. 3·9 per cent, while the power requirement for the 917 is only 17 hp, i.e. only 2·7 per cent of the engine performance of approximately 630 DIN hp.

Apart from the favourable effects on publicity, Porsche has always regarded its construction of racing cars and its participation in racing events to form a major part of its advanced development for production cars. For example, racing car experience has enabled Porsche to use lightweight magnesium material in their production of type 911.

Fig. 1 shows parts of the engine and gearbox for the 911 production car. All parts shown (except the cylinders) are of die-cast magnesium.

Twenty years of experience in the construction of performance cars preceded the 917 development. Fig. 2 shows the performance ratings for Porsche production and racing engines for the years 1960–70. There has been a remarkable increase in the performance of racing cars during the last 5 years; during this period the engine performance increased from 210 to 630 hp.

2 ENGINE

Fig. 3*a* shows the air-cooled 12-cylinder 917 engine with two overhead camshafts for each bank of cylinders. The engine has two valves per cylinder, twin ignition, i.e. two plugs per cylinder, and fuel injection.

The original 4·5 litre (274 in^3) version had a 85 mm bore with a 66 mm stroke and the engine developed approximately 565 DIN hp at 8400 rev/min. A 4·9 litre (300 in^3) engine was used for the first time in the world championship race at Monza in 1970. This version had a 86 mm bore and a 70·4 mm stroke which produced 600 DIN hp at 8300 rev/min. A 5 litre version with a 86·8 mm bore and a 70·4 mm stroke developed about 630 hp and was used in the 1971 Brands Hatch race for the first time.

Fig. 3*a* shows, in the foreground, the Bosch 12-plunger injector pump which was specially developed for this engine. It is driven via a tooth belt by the left-hand inlet side camshaft. The cooling blower is placed horizontally above the engine and is made from fibreglass-reinforced plastic. The induction tubes, the tube covers and the entire air ducting are made from the same material. The two twin-circuit distributors are visible in front of the blower and behind it.

All cast engine parts with the exception of the cylinder

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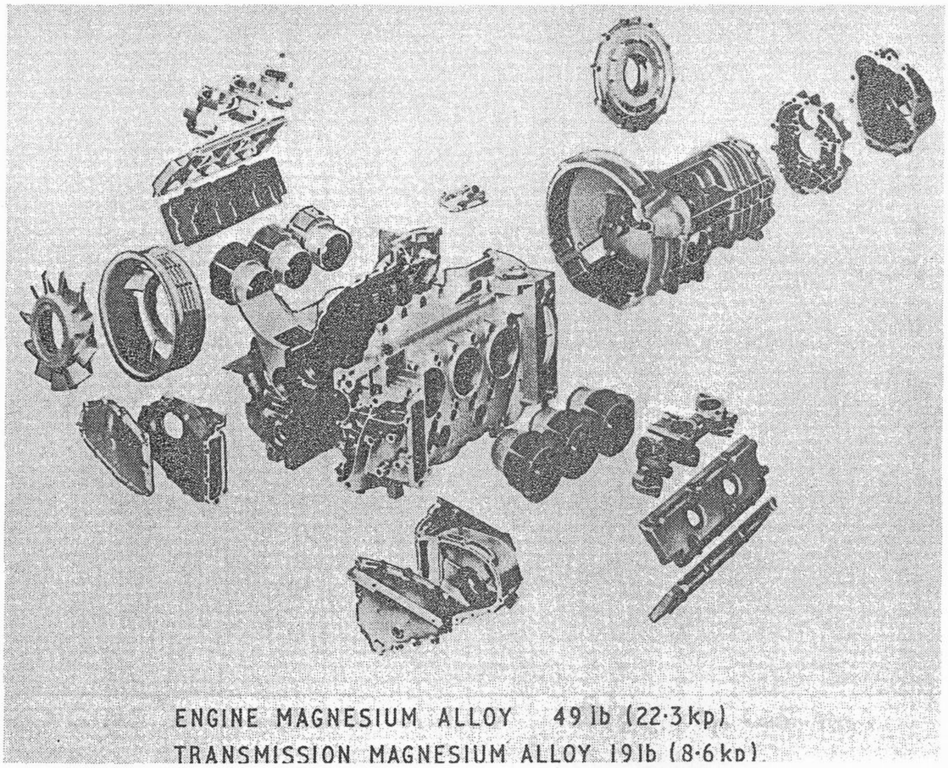


Fig. 1. Die castings of the Porsche 911

heads are made from RZ 5, a magnesium alloy to the United States specification ZE 41 A. This alloy has a high heat resistance, a good tensile strength and a homogeneous structure; furthermore the castings are resistant to pressure, even at small wall widths. The casting properties of RZ 5 are excellent. This magnesium alloy is only suitable for sand casting; but this is not important as castings for racing cars are generally cast in sand moulds in view of the relatively small number of parts involved.

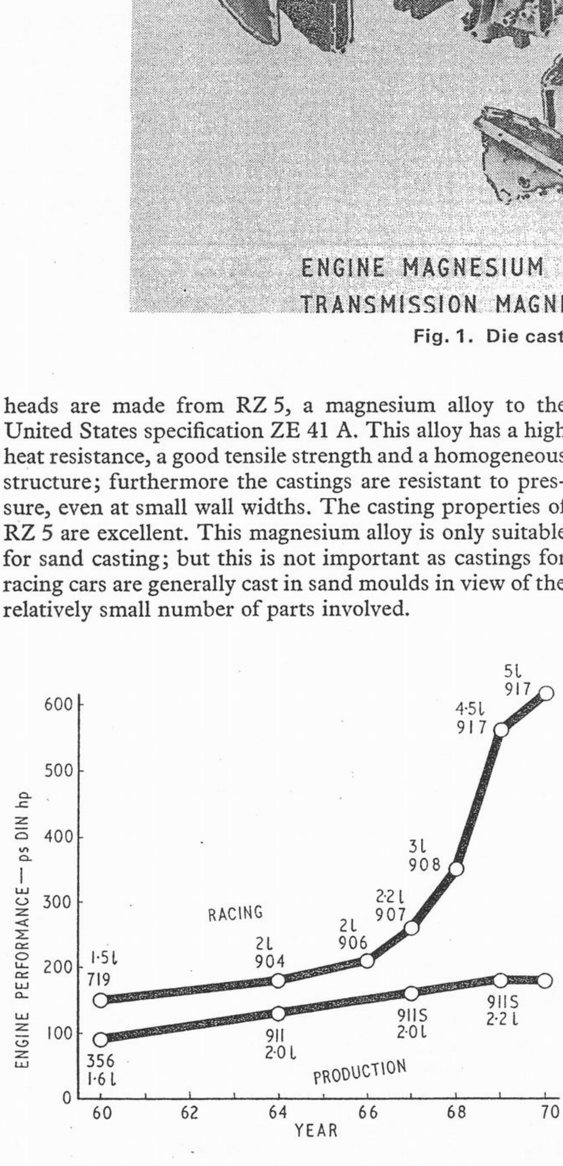


Fig. 2. Performance curves, Porsche engines

The weight of the complete 917 engine is 240 kg (528 lb). Total weight of all magnesium alloy parts is 70·7 kg (156 lb), i.e. 29·5 per cent of the total engine weight.

Fig. 4 shows the crankshaft of the 12-cylinder engine. The most spectacular design feature of this engine is its central drive. The engine power is taken via a pinion located at the centre of the crankshaft and is transmitted to the gearbox via a layshaft.

Every engine designer is aware of the difficulties caused by the natural vibration of the crankshaft which affects the moments created at the flywheel or the camshaft drive. All of these difficulties which are known to grow with the size of the engine—respectively with the length of the crankshaft—were avoided by using the central drive on the 917 engine.

Fig. 4 shows the shape of the natural vibration of the crankshaft which is 794 mm (31·3 in) long. At the centre of the shaft is a vibration node. This ensures that no torsional vibrations will occur at the central drive pinion. The four camshafts, the ignition distributors and the cooling blower are driven by this centre pinion. There are no overlapping vibrations and this is a major advantage, particularly for the valve gear drive.

There is no doubt that the more complex design of the central drive of the 917 engine has been worth while. Almost no mechanical problems were encountered during development of the different drives, and this is mainly due to the central drive design concept.

Fig. 5 shows a longitudinal section of the 917 engine; a photograph of the assembled right crankcase-half is also

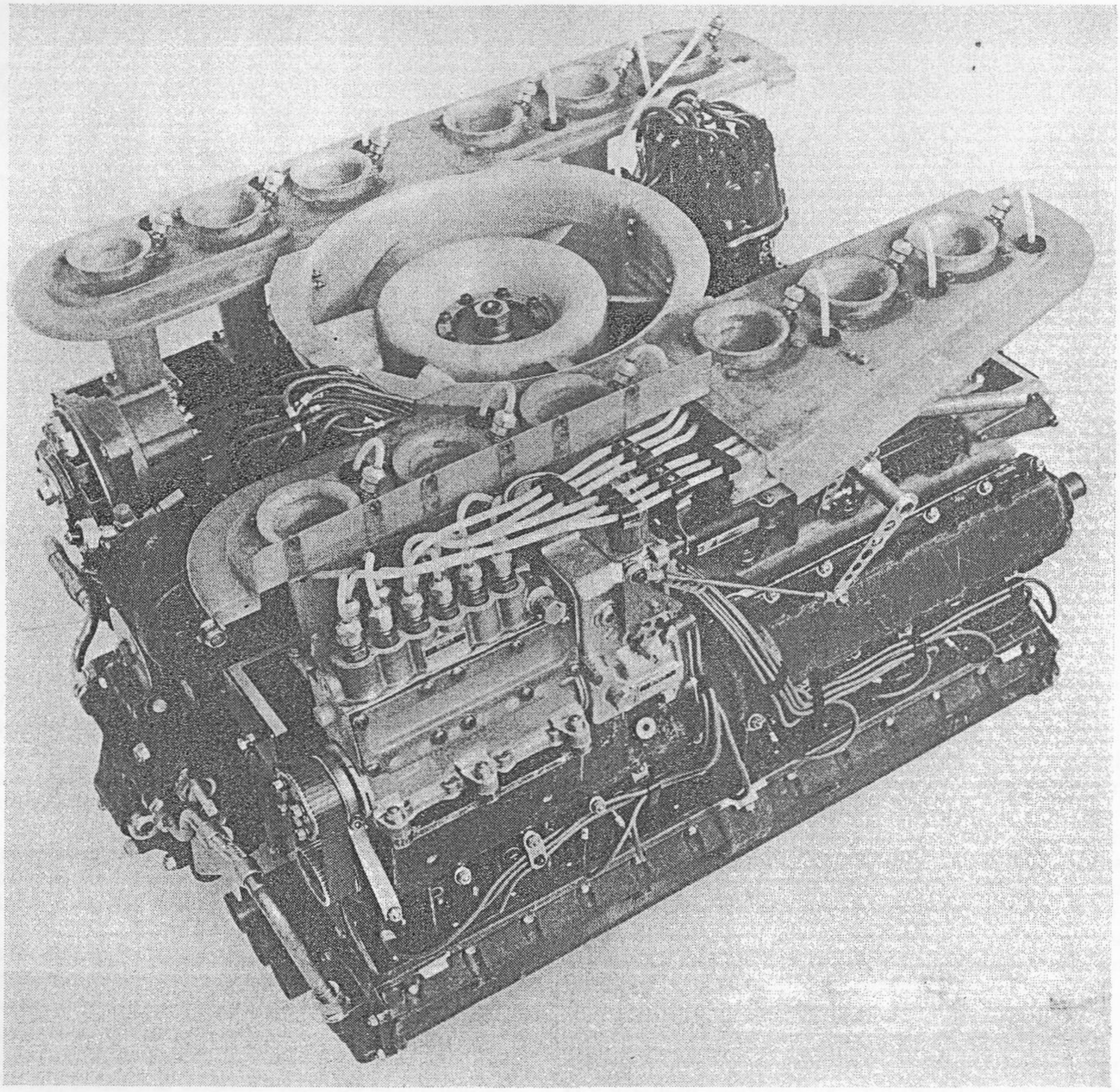


Fig. 3*a*. Porsche 12-cylinder 917 racing engine

shown for comparison. The power transmitting drive is easily recognized. The centre crankshaft pinion with its 32 teeth transmits the power via the lower pinion having 31 teeth, and the layshaft which is 22 mm (0·866 in) in diameter, to the clutch and gearbox. The layshaft acts like a torsional spring and will thus compensate for heavy shocks in the power transmission.

A titanium shaft of 24 mm (0·945 in) diameter to replace the steel layshaft was in the meantime successfully tested. The weight of the titanium shaft is 1·020 kg (2·25 lb) compared to the 1·585 kg (3·49 lb) of the steel shaft, a weight saving in this case of 0·565 kg (1·24 lb).

During the past few years titanium—we mainly use the alloy Ti Al 6 V 4—has become an everyday term in our racing car development. The strength and weight of titanium, compared with that of steel is far superior. For instance, the titanium alloy Ti Al 6 V 4 attains 110 kp/mm^2 (155 000 lb/in^2) which is the strength of first-class steel, but at only 57 per cent of the steel weight. However, there are a few applications requiring certain properties which are fulfilled by steel and not by titanium.

In compliance with the teeth relationship of 32:31 of the two pinions, the layshaft and clutch work at higher rev/min than the engine. The 1:1 relation was deliberately avoided as the matching of the same pair of teeth during every rotation is known to affect life endurance of a pinion gear.

As shown in Fig. 5, the main oil pump is located in the front crankcase and is divided into two scavenging chambers for the front and rear crankcase part and the actual pressure pump. The drive is effected via a pinion screwed to the front end of the layshaft.

Another layshaft drives the two ignition distributors and the alternator, and via two bevel gears the cooling blower is located above the crankshaft and is driven by the centre pinion.

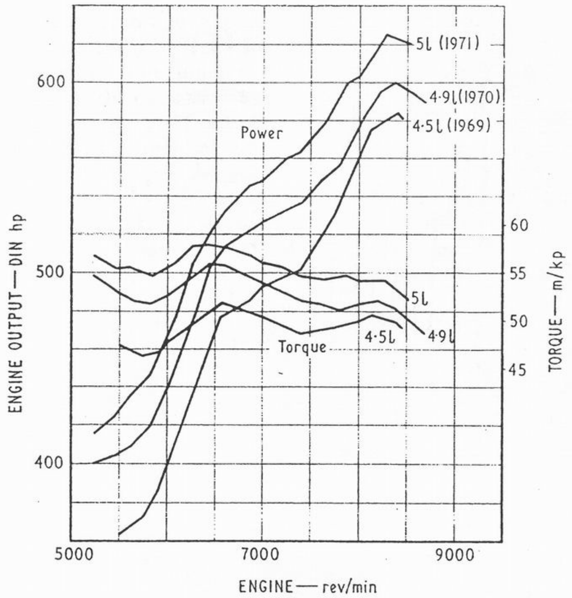


Fig. 3*b*. Output and torque of 917 engine

Fig. 6 shows a cross section of the 917 engine. The right half of the figure shows a centre section of the engine, i.e. at the central drive, and the position of the gear-wheels for the camshaft drives. The five pinion wheels between the crankshaft and the camshafts are located in one housing and mounted on pin bearings. An experimental engine combining, in its valve gear drive, steel, titanium and aluminium pinions was successfully tested.

The left half of the figure shows, among other things, the position of the front ignition distributor and its drive via the layshaft. The rear ignition distributor is positioned symmetrically in the right half of the crankcase.

Also shown in the left half of the figure are valve positions. The intake and exhaust valves are trepanned and have a sodium filling. The head of the intake valve has a diameter of 47·5 mm (1·87 in), compared to 40·5 mm (1·595 in) at the exhaust valve. The valve lift of the intake valve is 12·1 mm (0·477 in), that of the exhaust valve is 10·5 mm (0·413 in). Maximum valve acceleration is 0·0134 mm (0·000 528 in)/sq. degree cam angle; maximum deceleration is 0·0056 mm (0·000 220 in)/sq. degree. The intake valve is positioned at an angle of 30° to the cylinder axis and the exhaust valve at an angle of 35°.

The valves are actuated via cup-shaped cam followers. In our experience, the valve gear of the 917 engine could almost be called an optimum solution: a vibration-free drive from the crankshaft, a rigid power transmission via pinions and no flexibility in the valve actuation gear due to the cup-shaped cam followers.

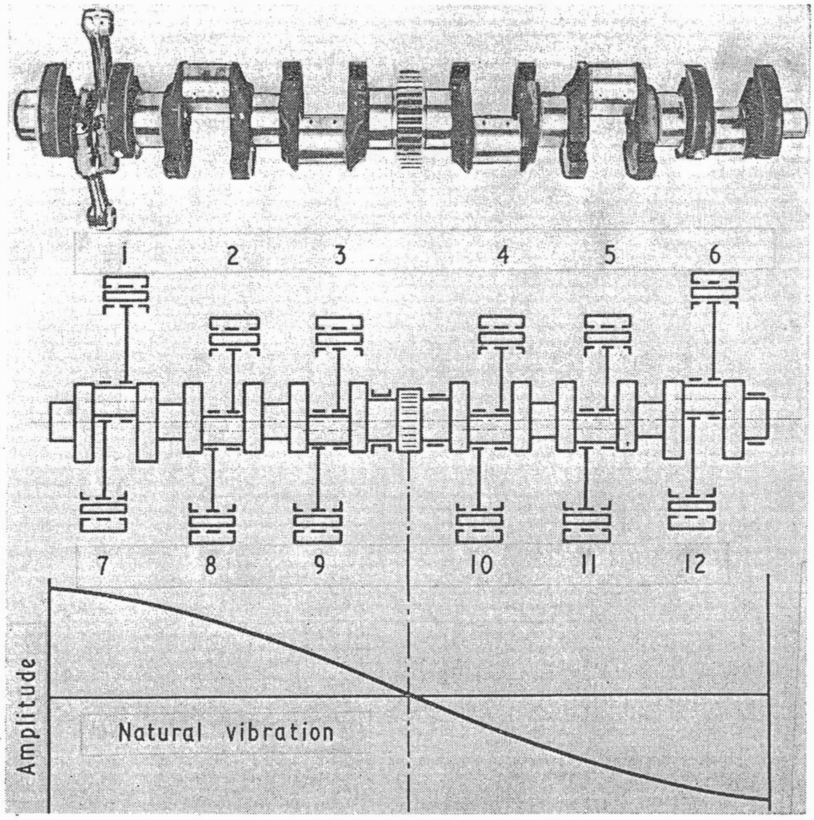


Fig. 4. Crankshaft of the 917 racing engine

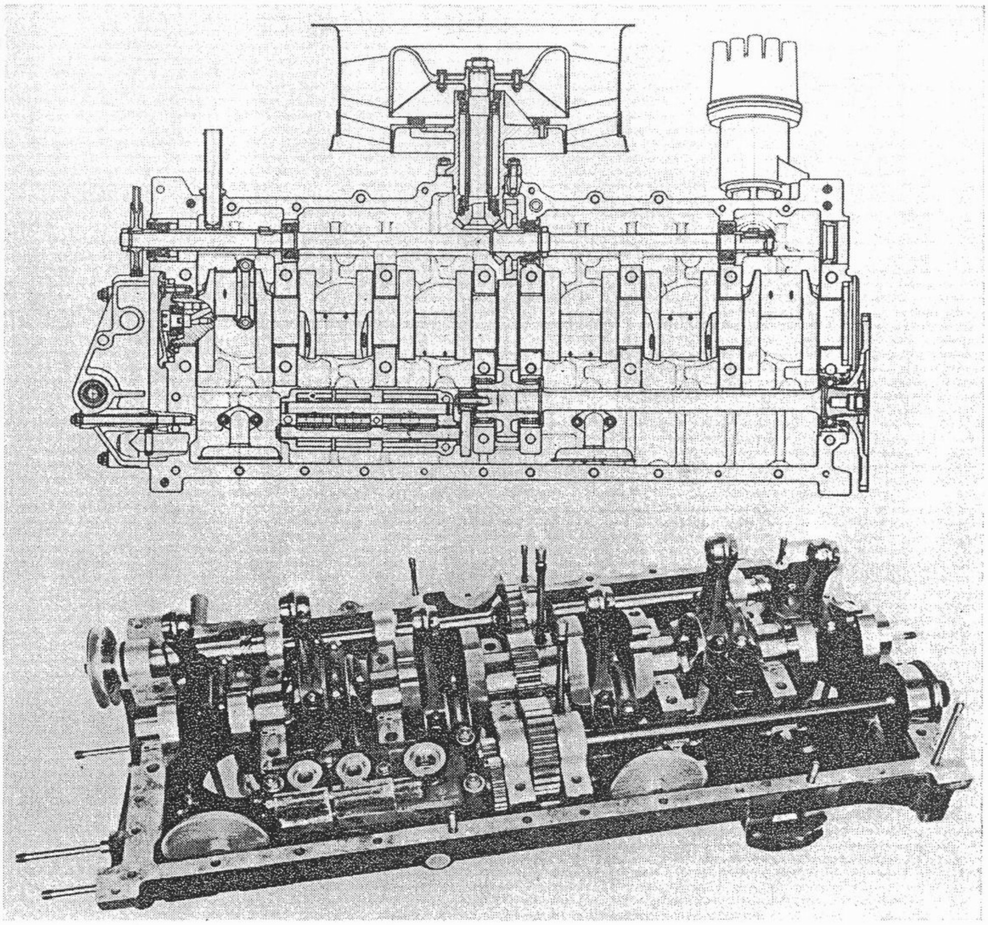


Fig. 5. Longitudinal section of the 917 racing engine

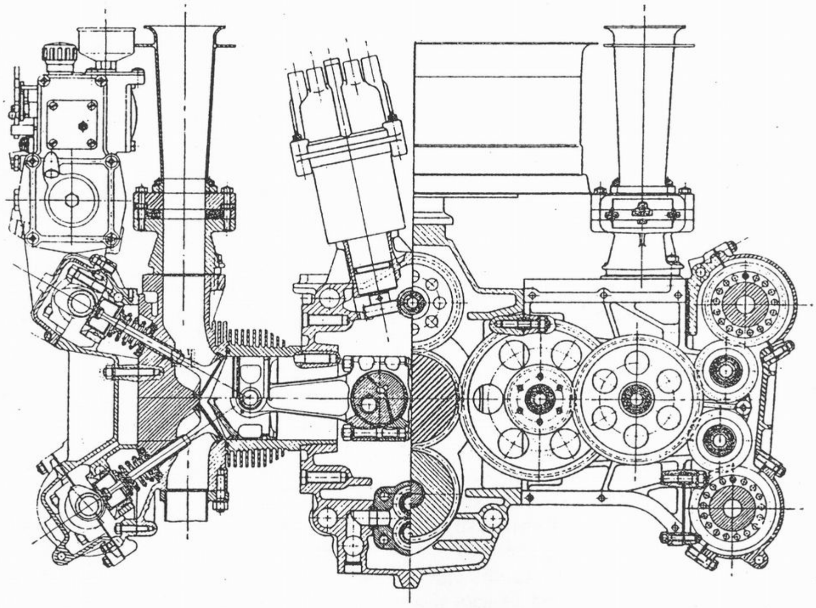


Fig. 6. Cross section of the 917 racing engine

Furthermore, due to the central drive the camshafts are also centrally driven, so that the torsion overlap is a minimum. The pinion at the camshaft has 17 bores and a collar at the camshaft has 16 bores. This differential spacing permits an exact and comparatively simple valve timing adjustment at the fully assembled stage.

At present our experiments on titanium intake valves have reached a stage which permits their use only in short distance races.

Besides their rigidity the cup-shaped cam followers which are used as transmission means between valve and camshaft provide further advantages, namely the admissible values of surface pressure are higher than for rocker arms and the lubrication is less problematic.

An interesting detail is the cam lubrication; oil is sprinkled through a small lubricating perforation, in the cam follower guide, on to the cams. When the valve is in the closed position the lubricating hole is closed by the cam follower itself. The oil outlet is opened only when the cam follower has achieved a lift of approximately 2 mm (0·08 in). Because of this lubricating arrangement the oil consumption of the valve gear can be reduced by about 60 per cent.

Fig. 7 shows the 12-cylinder engine crankshaft of the 917 compared to the crankshaft of the 3 litre 8-cylinder 908 racing engine; the crankshaft of the 6-cylinder Porsche 911 production engine and the Carrerra 6 racing engine. While with the flat-8 and flat-6 crankshafts only one connecting rod is positioned at each crankpin, the crankshaft of the 917, like a V engine, has two connecting rods per crankpin.

The 6-cylinder crankshaft has six crankpins and seven main bearing pins; the 8-cylinder crankshaft has eight crankpins and nine main bearing pins. With its only six crankpins and eight main bearing pins the crankshaft of the 12-cylinder engine is comparatively simple in shape, as can be seen in Fig. 7, with reference to the two other crankshafts. If the 917 crankshaft had been based on the design principle of one connecting rod per crankpin of the 6- and 8-cylinder engine crankshafts, it would have needed twelve crankpins, fourteen main bearing pins and a smaller torsional strength on the side.

The principle of the two connecting rods which could not be realized in the flat-8 engine as it would have implied a less favourable firing order permitted a reduction of the crankpin diameter to 52 mm (2·047 in) for the 917 in spite of its larger cylinder units compared to the 57 mm (2·244 in) of the 8-cylinder engine.

In view of the smaller number of bearings a reduction of the frictional loss could be expected and it was possible to enlarge the width of the main and connecting-rod bearings, a measure which is known to improve lubrication

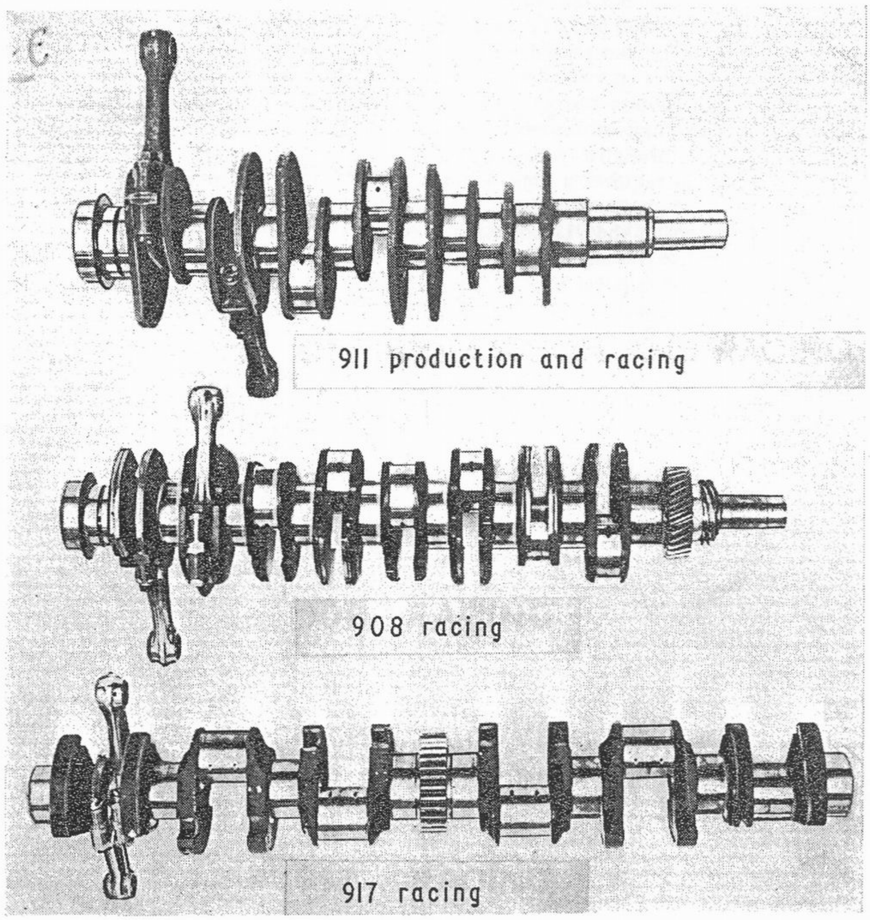


Fig. 7. Crankshafts of the Porsche engines

properties. Furthermore greater bearing widths entail a smaller oil throughput and thus less splashing.

The arrangement of the two connecting-rods per crankpin led to a reduced engine length, as the eccentric relation between the two cylinder banks does not correspond to one half of the cylinder spacing of 118 mm (4·65 in) but only to the width of the connecting-rod bearings, i.e. 24 mm (0·945 in).

With the exception of the 12-cylinder engine crankshaft the crankshafts of all Porsche engines which are now in production are made from heat-treated steel and tufftrided. This is a surface treatment in a salt bath at 570°C. Our measurements showed an increase of up to 50 per cent of the fatigue strength for tufftrided crankshafts. We could thus replace the originally used chrome–molybdenum steel in our 911 production engines (42 Cr Mo 4) by the less expensive carbon steel (Ck 45). Porsche uses tufftride or 'Tenifer' treatment for camshafts also.

The crankshaft of the 917 engine is made from chrome–nickel steel 17 Cr Ni Mo 6, as this shaft has to be case hardened because of its central drive.

There is another version of the 12-cylinder engine crankshaft in which the two crankshaft halves are made from tufftrided heat treated steel and electron beam welded to the case-hardened pinion.

One of the criteria of high-performance engines is the lubrication quality of the connecting-rod bearings. Fig. 8 shows the connecting-rod bearing lubrication of the Porsche engine, types 911, 908 and 917. In the 6- and 8-cylinder engines the oil is transported radially into the crankshaft which it reaches in two places—via the first main bearing and an additional supply bearing at the opposite end of the crankshaft—from where it reaches the connecting-rod bearings through a system of perforations. This lubrication method requires a high oil pressure at high engine speed.

The oil feeding system of the 917 engine is different. It is more efficient because it is almost independent of the engine speed and requires a lower oil pressure. Because of the central drive the crankshaft ends of this engine are free and lubricating oil is fed into the shaft axially from both sides.

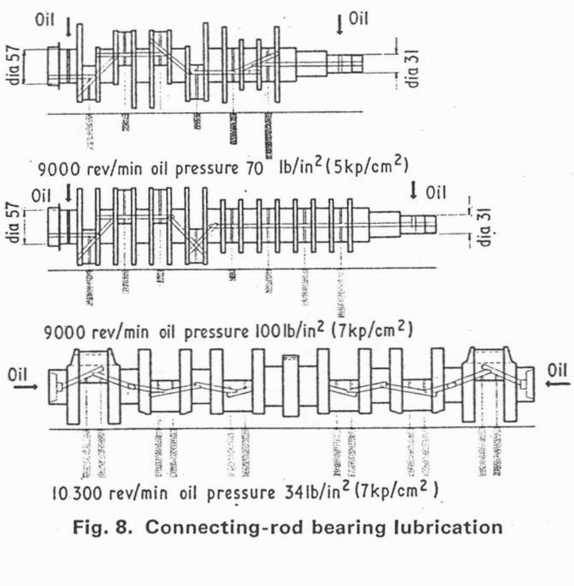


Fig. 8. Connecting-rod bearing lubrication

My company ran comparative tests with the three crankshafts which produced the following results: for the 6-cylinder crankshaft 5 kp/cm² (70 lb/in²) were required to provide an adequate oil supply at an engine speed of 9000 rev/min; the longer 8-cylinder engine shaft required 7 kp/cm² (100 lb/in²) for the same engine speed, but in the case of the 917 crankshaft 2·4 kp/cm² (34 lb/in²) were sufficient even at speeds of 10 300 to 10 500 rev/min.

The oil circuit is an important feature of every high performance engine. It is one of the major factors for engine stability, but also for engine performance. On the one hand all bearings, pinions and cams need an adequate oil supply; on the other hand it is necessary to keep oil throughput at a minimum in order to avoid splashing losses as far as possible. The design of the 12-cylinder engine was aiming at a lubricating system with minimum splashing. The engine was so 'dry' that in its early stages there arose certain difficulties with the piston temperatures. On the other hand, the quite exceptional performance of the engine in its first bench tests in March 1969 justified all efforts.

Fig. 9 shows the oil circuit of the 917 engine; it is a dry sump lubrication which is standard for racing engines. The main oil pump is divided into two scavenging pumps, scavenging the front and rear crankcase and the pressure pump, and is located in the crankcase (see Fig. 5).

The oil filter case contains an adjustable pressure relief valve which maintains a constant pressure of 5 kp/cm² (70 lb/in²) for the crankshaft assembly. The oil expelled by the relief valve is not fed back into the crankcase. It returns directly to the pressure pump.

A throttle valve reduces the oil pressure for the cams and camshaft bearings to 3 kp/cm² (43 lb/in²). Four small scavenging pumps at the ends of the exhaust camshafts will keep the camshaft housing as dry as possible.

As it has been shown, this engine has seven oil pumps, six of which work as scavenging pumps; the extracted oil is transported to the oil tank. When the oil temperature rises above 85°C, a thermostat operates and the oil flows through the oil cooler at the front of the car.

In general it could be stated that for the 917 racing car, steel is used only if and where titanium and other light alloys are not or less suitable.

A special problem had to be solved in connection with the vertically divided crankcase and the mounting of the cylinder heads. The two-bolt connections are shown in Fig. 10.

Magnesium and aluminium have a mean coefficient of thermal expansion of approximately 22×10^{-6} to 24×10^{-6} per degree centigrade.

The corresponding value for titanium is $8{\cdot}2 \times 10^{-6}$. The combination of a titanium bolt and a magnesium or aluminium part causes the bolt to expand only about one third of the expansion of the corresponding part. The 'cold' initial stress is thus enhanced by an additional expansion differential which will either induce a bolt rupture or a distortion of the magnesium or aluminium parts which in turn entails an undesirable reduction of the initial stress.

If normal steel bolts of a thermal expansion coefficient of $11{\cdot}5 \times 10^{-6}$—which is about half of that of magnesium or aluminium—are used, the difficulties are essentially the same. The solution of the crankcase and cylinder head bolt problem was found to be Dilavar. This is a special

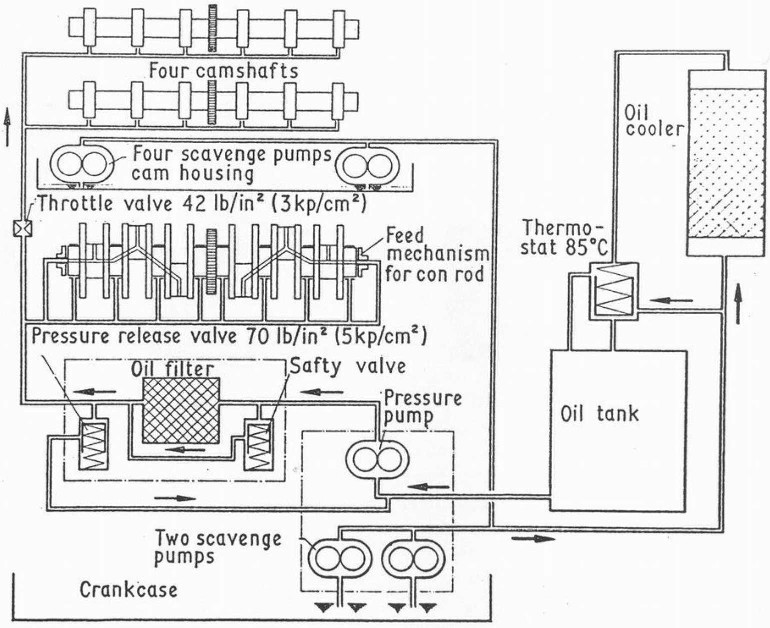


Fig. 9. Oil circulation of the 917 racing engine

steel alloy having a thermal expansion coefficient of approximately 20×10^{-6} per degree centigrade. When the engine is heated, Dilavar bolts will thus expand almost at the same rate as magnesium and aluminium. In addition the cylinder head bolts are insulated by fibreglass, otherwise the cooling air flow would cause the temperature level of the bolt to fall far below that of the cylinder.

Section A in Fig. 10 shows a bolt/nut combination of the type used for the crankcase assembly. Ruptures tended to originate from the last screw winding under load—this is known to be the highest stress region, where the load is increased by a notch effect. All risks were eliminated by replacing the flat washers with spherical ones which avoid bending stress in the thread windings. Furthermore, the bolt end and the nut were extended and shaped in a way that the female thread projects a few millimetres beyond the bolt thread. This will also reduce the notch effect.

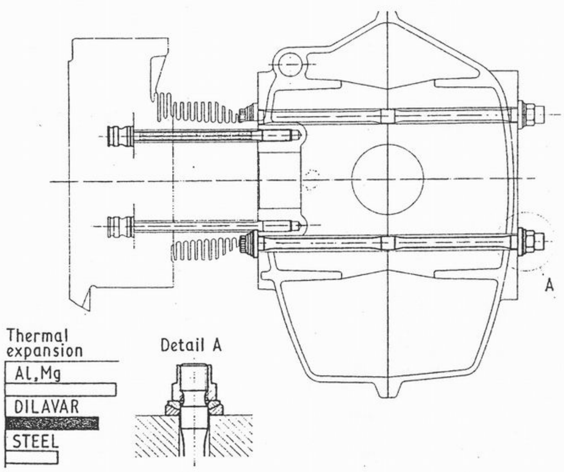


Fig. 10. Crankcase and cylinder head bolts

The first titanium part used by Porsche in a car construction was a connecting-rod 10 years ago. Since that time all our racing engines use titanium connecting-rods, and a lot of experience about the possibilities of this light but high-strength material has accumulated. Today, price considerations are the only obstacle preventing application to production cars. For forged parts the price in titanium is about twenty times that in steel.

In the design of titanium parts the higher notch impact sensibility of titanium compared to steel has to be taken into account. Forged parts need larger transition radii, i.e. softer contours, as the flow characteristics of titanium are inferior to those of steel.

Furthermore the sliding characteristics of titanium are inadequate. In most applications this disadvantage can be eliminated by a surface treatment or coating such as flame plating. Porsche uses a surface treatment called 'Tiduran' to improve the sliding characteristics. Tiduran means a normally two-hours treatment in a cyanogen bath at 800°C.

Fig. 11 shows the forged connecting-rods used by Porsche: on the left the steel connecting-rod of the 911 6-cylinder production type weighing approximately 0·680 kg (1·5 lb), in the centre the titanium connecting-rod of the 8-cylinder racing engine, 908, weighing 0·420 kg (0·92 lb) and on the right-hand side the 917 titanium connecting-rod weighing 0·420 kg (0·92 lb).

The bolts for the titanium connecting-rods are also made from titanium. The corresponding bearings are shown below the connecting-rods. Collar end bearings are used for racing engines. These bearings provide a smaller oil throughput and improve lubrication properties.

The air-cooled Porsche engines have individual cylinders. Fig. 12 shows three different types of cylinders and the corresponding pistons. The 2·2 litre production engine 911T producing 125 hp uses cast-iron cylinders. The 155 hp and 180 hp 911 production engines use so-called

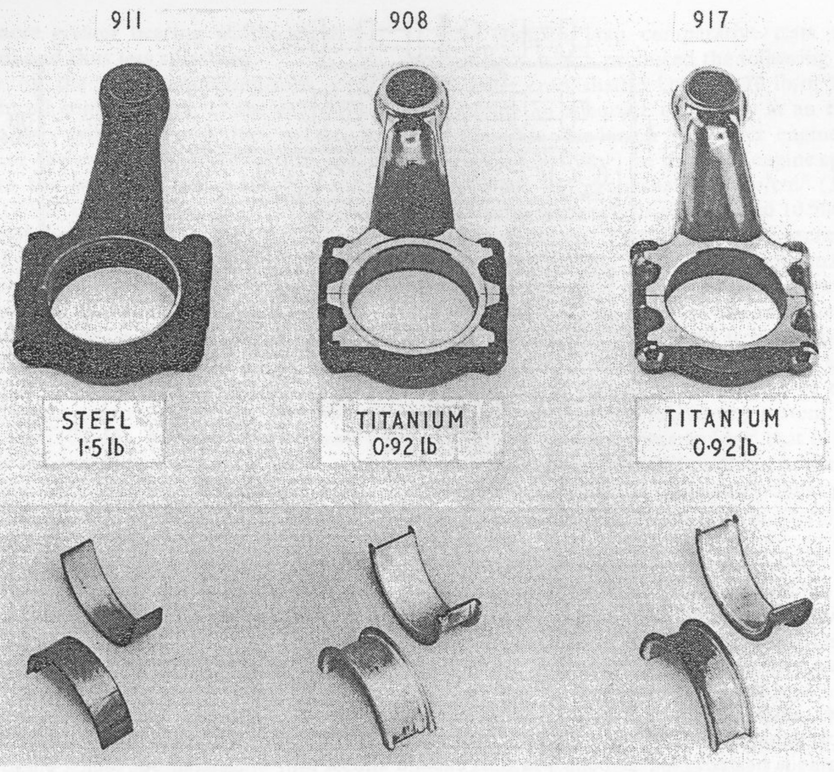


Fig. 11. Connecting-rods of the 911, 908 and 917 engines

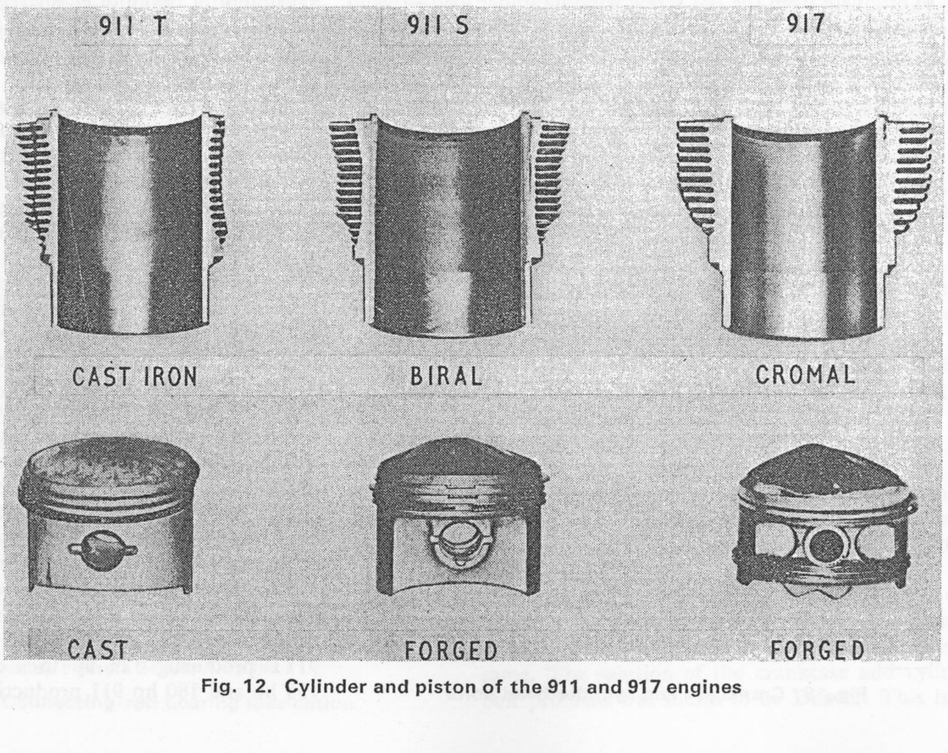


Fig. 12. Cylinder and piston of the 911 and 917 engines

'Biral' cylinders. A Biral cylinder consists of a cast-iron cylinder barrel around which aluminium is cast in a die-casting process.

Like all racing engines the 917 has Cromal cylinders. These cylinders are forged from an aluminium alloy, machined and then coated with a chrome sliding layer. Small holes are rolled into the chrome layer, these holes absorb oil and thus improve the sliding properties.

The pistons of the racing engines and the 180 hp production engines are forged in aluminium. All other production types use cast aluminium pistons.

One of the individual cylinder heads of the 917 engine is shown in Fig. 13. The cylinder heads are chilled in an iron mould from a heat-resistant aluminium alloy. The cylinder head is the only aluminium casting of the engine. As already mentioned all other castings are made from the still lighter magnesium.

The combustion chamber is formed by the spherical cylinder head surface and a spherical-shaped piston crown. The axes of the intake and exhaust valves intersect in the centre of the cylinder head sphere.

The combustion chamber design shown in Fig. 13 has also achieved optimum results for production engines. The position of the two sparking plugs whose platinum electrodes protrude into the combustion chamber creates short combustion paths. This kind of combustion chamber has a small surface, shows no fissures and induces an optimum combustion process as indicated by the favourable late ignition point of 27° crank angle before top dead centre (t.d.c.).

The cylinder head seal shown in Fig. 13 which Porsche has been using for years in all engines works without any problem. It consists of a C-shaped metal coat into which a hose spring has been inserted.

Porsche have been using fuel injection in their racing engines for several years. The injection pump of the 12-cylinder engine was developed for this particular type of engine. Each engine cylinder possesses its own plunger. These plungers are arranged in two banks in a magnesium housing (see Fig. 3) and are actuated by cams. The fuel volume is controlled via a three-dimensional cam dependent on the position of the throttle slides and the engine speed. Nylon tubes are used as injection ducts. They are all of the same length in order to avoid deviations in the injected fuel volume and the injection point between the individual cylinders. The injection valves have an ejecting pressure of 18 kp/cm^2 (255 lb/in^2) and are located at the upper rim of the induction funnels, as optimum performance is achieved when the injection point is located at the greatest possible distance from the intake valve.

In order to avoid the accumulation of fuel in the induction system when the slide is in the closed position—for instance during the braking process when entering a curve—the specially shaped three-dimensional cam will interrupt the fuel supply at an engine speed of more than

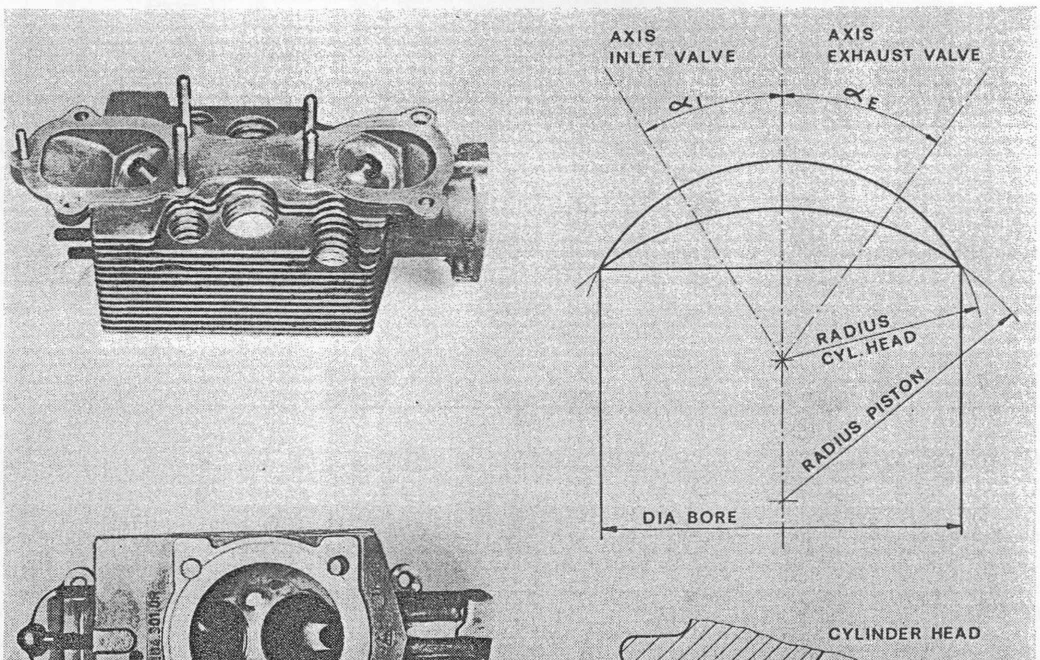


Fig. 13. Cylinder-head combustion chamber

4000 rev/min. Below this speed the injection volume will again increase to the volume required for idle. A pressure transducer adjusts the injection volume dependent on ambient pressure.

The Porsche production cars 911E and 911S work on the same principle as the described injection system of the 917.

The cooling blower is arranged horizontally above the engine. It has a diameter of 330 mm (13 in) and supplies the cooling air for the engine at a rate of approximately 2400 l/s at the rated engine performance. The blower is driven via bevel gears at a ratio of 17:19 of engine speed. As already mentioned, at maximum engine power the power input to the blower is 17 hp, i.e. 2·7 per cent of the engine performance. Of the entire cooling air volume 65 per cent is used to cool the cylinder heads and 35 per cent for the cylinders.

3 POWER TRANSMISSION

Porsche develop not only all gearboxes for their own use but also for other companies. There is a special Porsche locking synchronization which is built by other companies under licence—our racing-car gearboxes use this synchronization system.

Fig. 14 shows the 917 gearbox. It is designed for five forward gears and one reverse gear. During actual use it was shown that in view of the wide speed range and the flexible behaviour of the 12-cylinder engine, a four-gear version is completely satisfactory for most race-tracks.

A gear pump is located at the rear end of the clutch shaft, its purpose being to sprinkle oil to the crown and pinion and the gear wheels.

The gearbox is equipped with a laminated differential locking device with adjustable (in our case about 75 per cent) locking ratio.

The gear cases are cast in the heat-resistant magnesium alloy RZ 5 (ZE 41 A) and weigh 21·3 kg (47 lb). The same material is used for the engine castings.

Fig. 14 also shows a triple disc clutch used in the 917. The driven clutch discs are only about 2·5 mm ($\frac{1}{10}$ in) wide and use sinter pads.

4 CHASSIS AND BODY

The design of a racing car is defined by the sports regulations, the road performance and safety considerations. Apart from certain prescriptions with reference to the internal dimensions of the cockpit, the tank volume and

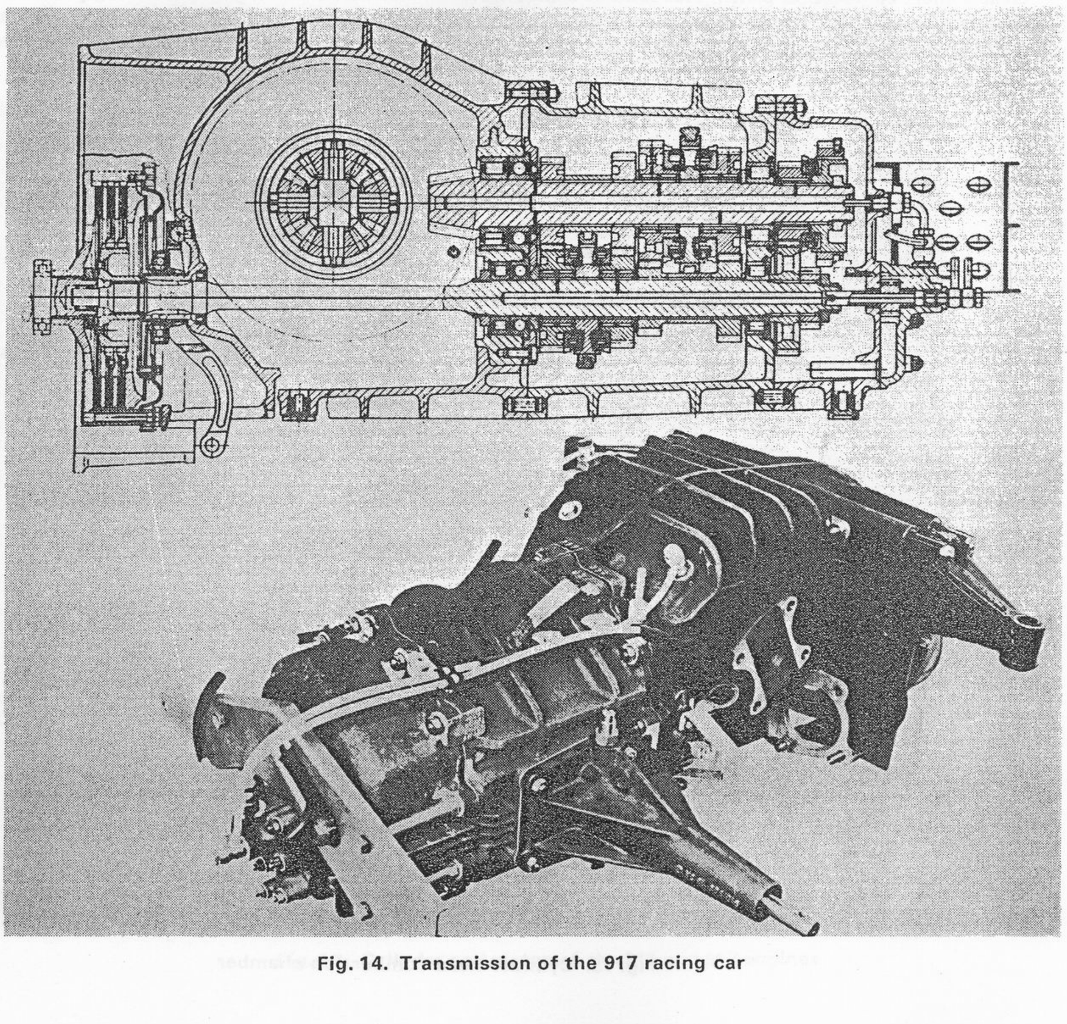


Fig. 14. Transmission of the 917 racing car

the minimum weight, etc., the task of a racing car designer can generally be worded as follows: how to create a car which will run a predetermined racing distance at a workable effort of the driver and without any risk to the driver's health in the shortest possible time. This has to be taken into account in the solution of all detail problems of racing car technology. Not only the smallest air resistance, the lowest weight or a maximum value of the attainable transverse acceleration of the car alone are decisive, but an optimum result of the entire task.

A racing car which is thought to be the car without compromise is actually an ideal compromise representing the most favourable combination of all pertinent factors like weight, engine power, air resistance, lateral load, straight-on drive, braking performance, fuel consumption, wear of tyres and brake pads. The driver's comfort, i.e. seating position, visibility, use of pedals, steering wheel and gearshift, readability of controls and cockpit air conditioning are also important.

Finally the influence of a psychological aspect should not be forgotten. The real speed of a racing car is not primarily determined by the engine power and different kinds of driving resistances but by the confidence of an experienced driver with a sense of responsibility in the car, expressed in the speed he dares to realize without risks. The driver needs a feeling that the car will not act uncontrollably in limiting conditions but will respond exactly to his intentions.

Porsche have invested a lot of time and effort in lightweight structure and safety—there is a direct connection between the two. Research activities in this direction have continued steadily for years—and quite successfully. This continuous progress in the field of lightweight structures has not only secured Porsche's predominance in the construction of extremely light racing or performance cars, but it has also created vital knowledge for the progress of technology.

Of course lightweight structure is a genuine and justified improvement only if safety is warranted. No part which is susceptible to failure or influences safety is applied without testing.

The racing cars are subject to an endurance shatter test on the Porsche testing grounds to try out the chassis and chassis parts; this means a much higher stress than on racing tracks.

The engine is subject to an 18 h endurance bench test at full load.

The power transmission parts are tested in a specially defined race-track simulation programme on the chassis dynamometer including all pertinent gearshifts, acceleration and braking modes.

It is hardly justified to send a car to races without extensive preliminary testing. But of course even the most thorough preparations will not be a 100 per cent guarantee for success; unpredictable events arise during each race and may jeopardize success. For instance there were a lot of tyre failures during the past few years. This, among other things, is due to the fact that the tyres of today are subject to higher stresses induced by the greater lateral acceleration and speed attained by modern racing cars. Besides the breaking away of tyre treads most of the failures were due to the tyre bead lifting or being pressed away from the rim so that the air could escape rapidly. This has been remedied by the incorporation of a hump at the outer periphery of the rim, besides the tyre bead.

As well as the measures of active safety—such as the extensive mechanical chassis test on the shatter track—the 917 has been equipped with passive safety devices, part of which are prescribed by F.I.A.

The fuel, the volume of which is restricted by regulations to 120 l (26·4 Imperial gal.) is contained in a receptacle constructed as a safety tank. The tank has a flexible outer coating which is resistant to shocks and flames and is filled with polyurethane foam. This foam material which fills 3–5 per cent of the volume serves several purposes. It prevents the collapsing of the tank and the wobbling of its contents. Furthermore it serves as a flame barrier acting against explosion of the fuel–air mixture and induces the fuel to leak out only slowly through a possible hole. The safety fuel tank is located in an aluminium cup on the right-hand side of the car between the front and rear wheel.

Furthermore the 917 possesses a fire extinguishing system which can be brought into effect either manually or automatically via a temperature or acceleration switch or optically. The system works by means of a gas (Halon 1211—bromchloride fluormethane, $C\,Br\,Cl\,F_2$) which is conducted to the critical places of the car, like cockpit, tank and engine compartment where it can emerge through a multitude of small perforations.

Two clearly marked switches—one is accessible from the driver's seat, the other from the outside—permit the interruption of the electric circuit.

Finally the 917 is equipped with a safety belt and an effective three-dimensionally supported roll-bar made from 45 mm (1·77 in) tube.

In 1967 Porsche developed a tubular chassis made from aluminium tubes for a light 2 litre racing car which was to run in the events for the European hill-climb championship. The distance of hill climbs was very short, so that checking intervals were equally small.

A failure of the tubular chassis was hardly to be expected, as the car had, of course, been tested on the jolting track. Even so the tubular chassis was regularly checked. For easier tracing of possible cracks the hollow spaces of all tubes under load were connected by perforations and the tubular system was filled with compressed air. In this way a dependable check of the state of the tubular frame was possible at any time by measuring the air pressure in a pressure gauge. A crack in a frame tube would immediately induce a sharp pressure decrease.

Early in 1968 a racing car using an aluminium tubular frame was used in a long-distance race; a 2·2 litre 907 car finished the 24 h of Daytona. That same car had already completed almost 30 h of practice on the same track before the race. In our experience aluminium tubes are excellent and we could use this material for the 917 frame without reservations.

Fig. 15 shows this frame which weighs 47 kg (104 lb) complete with all suspension parts and fixtures but without the tank cup. Depending on the load intensity, tubes of one of the following dimensions is applied: $20\times1{\cdot}6$ mm ($0{\cdot}79\times0{\cdot}063$ in), $25\times1{\cdot}6$ mm ($1\times0{\cdot}063$ in), $30\times1{\cdot}6$ mm ($1{\cdot}18\times0{\cdot}063$ in), $32\times2{\cdot}5$ mm ($1{\cdot}26\times0{\cdot}1$ in) and 35×3 mm ($1{\cdot}38\times0{\cdot}118$ in).

The strength of the tube is 38 kp/mm^2 (52·500 lb/in^2); the tube connections are effected by shielded arc welding.

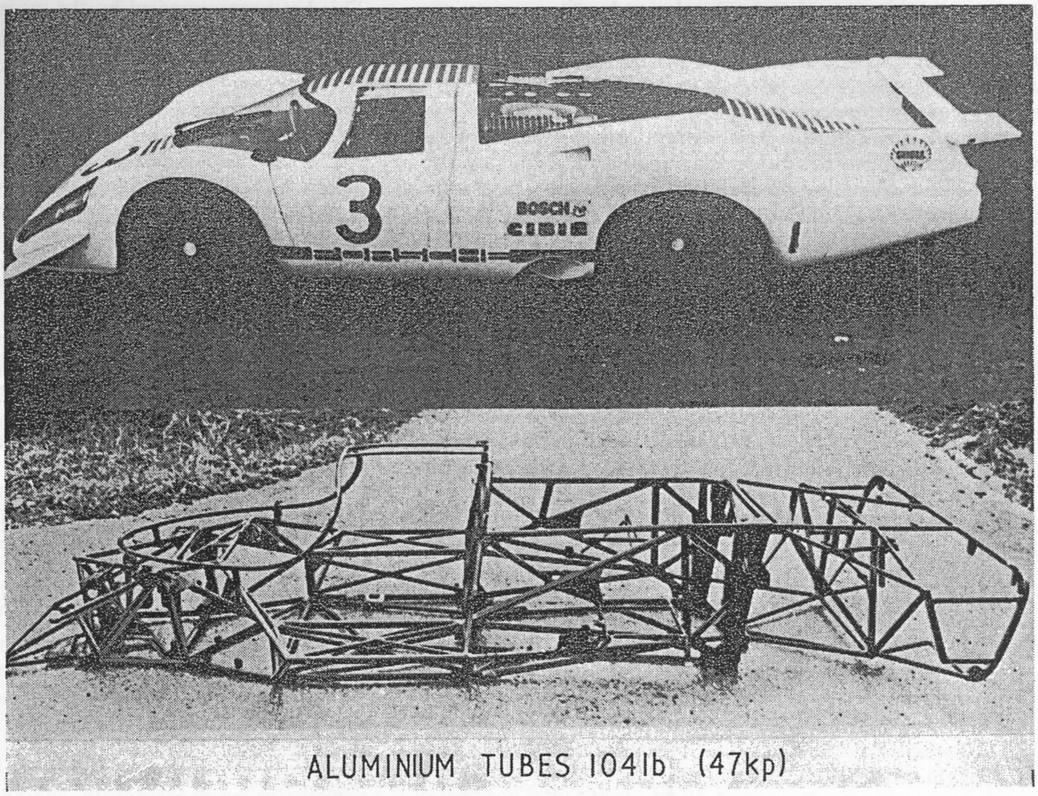


Fig. 15. Tubular frame of the 917 racing car

Some of the tubes serve as supply and return ducts for the oil cooler in the car nose in order to save oil hoses.

During the past few years racing tyres experienced a remarkable development. Their cross section became lower and their contact area wider and almost flat. For instance, the contact width of the 917's rear tyres is approximately 380 mm (15 in). The racing tyres which are used at present are able to transmit longitudinal and transverse accelerations of 1·4*g* and more—always provided that the wheel position with reference to the ground surface is right. Balanced wheel kinematics and an optimum suspension and stabilizer adjustment are required to take full advantage of the features of modern racing tyres. Exact wheel guiding is of the same importance as kinematics. Elastic distortions of the wheel suspension—of the frame or of the suspension arm side—should be as small as possible. Rubber bearings which are usually used in production cars, formerly also in racing cars, are therefore to be avoided.

The wheels of the 917 are suspended at double transverse suspension arms. This suspension system represents an optimum solution for the numerous requirements. It is light and provides ample tolerance for the adjustment of wheel kinematics.

Fig. 16 shows the suspension and mounting of the 917 front wheel. The longitudinal load is borne by longitudinal wheel suspension struts with a wide base at the tubular frame—this is not visible in the figure—an arrangement which will ensure more accurate steering as well as a more favourable load transmission to the tubular frame.

Solid-drawn aluminium pipes are used for those suspension arms which are exclusively subject to tensile stress and pressure—not to bending loads. The ends of these tubes into which threads are screwed are rolled conically.

The ball pivots on the wheel side are adjustable and have a titanium housing. The spherical bearings of the suspension arms on the chassis side are equipped with Teflon bushings and are made from titanium. The front and rear uprights as well as the 15-in rims are cast in magnesium.

The front and rear wheel hubs are made from a titanium alloy; the mounting cup of the brake disc and the central nut are forged from an aluminium alloy.

Fig. 16 also shows the rack and pinion steering gear with its titanium rack and pinion and its magnesium-cast housing.

The suspension springs of the 917 are made from titanium. The required progressive characteristic of this spring is not achieved by the usual variation of coil upgrades but by a conical grinding of the titanium wire as it is shown by the photograph.

Besides the already mentioned factors of wheel kinematics and steering, the amount of unsprung weights will equally exert a major influence on the qualities of road behaviour. On corrugated or uneven roads the wells and the suspension system are subject to inertia forces. These forces are transferred to the chassis via the suspension springs and the shock absorbers and affect the road behaviour to a greater or lesser extent dependent on their magnitude. In certain cases they may induce the

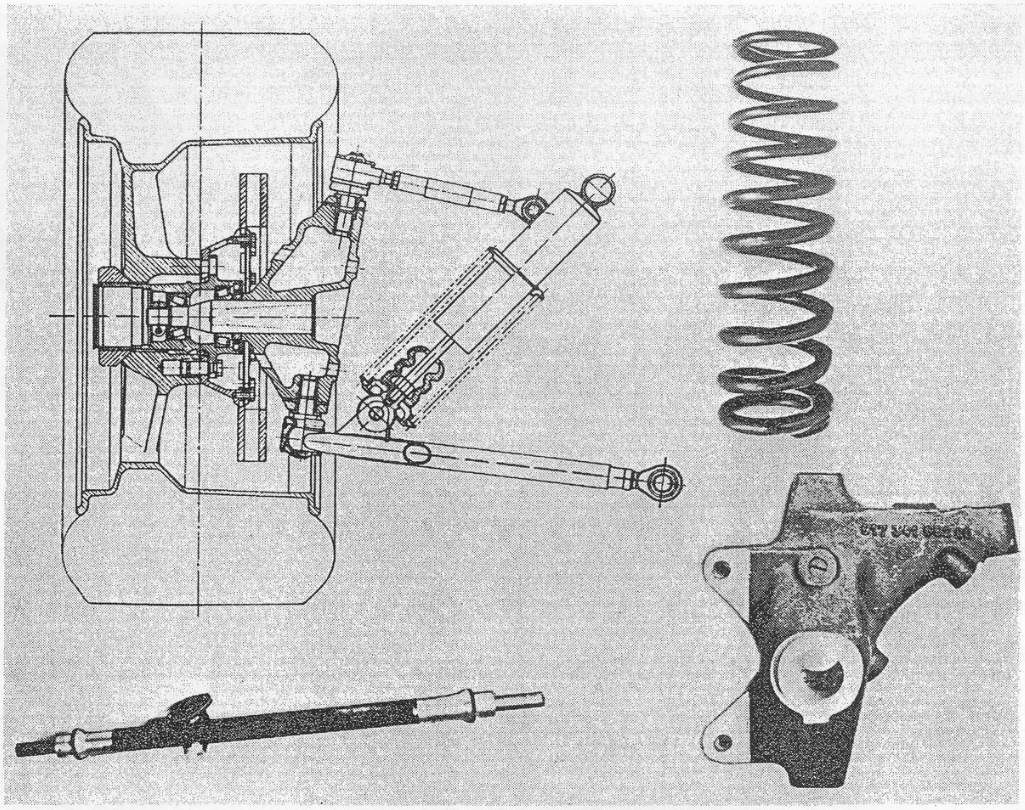


Fig. 16. Front suspension of the 917 racing car

wheels to lift off the ground, i.e. a loss of the necessary contact between the tyres and the road surface. As the magnitude of the detrimental forces is proportional to the amount of unsprung weight, it is necessary to make the corresponding parts as light as possible—within the safety limits. At present the 917 has already achieved a satisfactory level by using titanium, aluminium and magnesium; nevertheless development efforts continue in this direction.

The brake calipers and the 28 mm (1·1 in) wide internally ventilated brake disc made from special cast iron make up approximately 9 kg (20 lb) per wheel, i.e. a major part of the unsprung weight. Combined with the functional improvements of the braking system continued efforts are made towards a weight reduction of these relatively heavy parts. Porsche has its own braking test-bed in which all improvements and weight reductions of the brake calipers, the pistons, the braking hoses, pads, discs, etc. are tested.

The ability of the braking system to meet any emergency of the 917 which weighs 970 kg (2150 lb) with its tank full and attains a top speed of approximately 385 km/h (239 mile/h) are high. The braking performance is not only a matter of safety, it also exerts a direct influence on the driving performance. In racing conditions, the braking time of the 917 is about 15–18 per cent of the total.

The 917 has a dual circuit braking system incorporating one main cylinder each for the front and rear wheels. An adjustable swingletree is located between the brake pedal and the two cylinders and allows for an accurate adjustment of the brake force distribution between front and rear.

The brake caliper is made from aluminium and has four pistons. The front wheel brakes which are subject to a major part of the load receive additional cooling air through air slits in the car nose and hoses.

Fig. 17 shows the mounting and the suspension of the rear wheel and the drive shaft. The rear axle parts are made from the same materials as the corresponding front axle parts; however, some of the parts have larger dimensions than those of the front wheels on account of the higher loads.

The drive shaft which is shown in Fig. 17 has two universal joints: a longitudinal adjustment based on ball races and a flexible coupling absorbing the torque shocks. The two parts of the drive shaft which need to be hardened on account of the ball races are forged in steel, the other three shaft parts in a titanium alloy.

The 917 has to be an all-round racing car as it will be used on very different types of race-tracks; in 1971 the manufacturers' world championship had eleven races.

The Nürburgring track requires cars with a large spring travel stroke—the 917 has about 170 mm (6·7 in)—which complicates the wheel kinematics. Half of this travel stroke is sufficient for Le Mans. For the Nürburgring track the springs should be as soft as possible. Le Mans, however, requires harder springs, as on this fast track large spring movements of the car will, among other things, induce a detrimental effect on the aerodynamic stability.

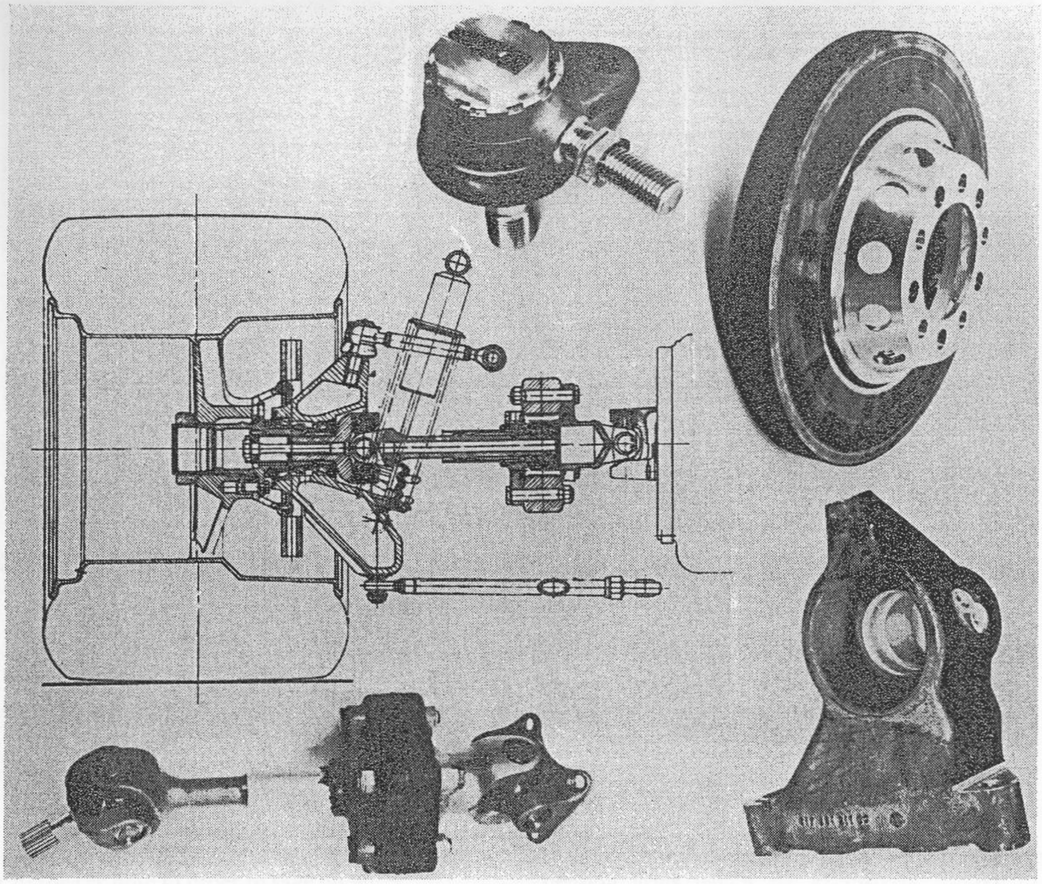


Fig. 17. Rear suspension of the 917 racing car

For Le Mans a car needs excellent straight-on drive characteristics and for the Nürburgring an excellent curve behaviour. At Le Mans 66 per cent of the lap time is driven at full load and about 16 per cent at partial load in curves. On the Nürburgring full load conditions make up only 39 per cent of the lap time, and 46 per cent in curves.

An increase of 10 per cent of the attainable transverse acceleration would reduce the lap time on the Nürburgring to a value which could not be achieved even by doubling the engine power. At Le Mans, however, a 15 per cent increase of the engine power will achieve the same result as a suspension improvement of 10 per cent.

The Porsche racing development also takes advantage of electronic data processing. A computer calculates the race-track lap times which are to be expected and determines the optimum gear ratios for the different kinds of tracks. Furthermore, the race-track programme provides a simple means to determine the measures which will achieve the best results in a special race.

Furthermore, the driving diagrams calculated by the computer have shown that during the races the cars are driven at curve speeds which are even higher than those corresponding to the transverse acceleration values of 1·4 to 1·5*g* determined in the 190 m (600 ft) circle of the Porsche skid pan. This is partly due to the body shape creating downward pressure and thus increasing the wheel load.

Fig. 18 shows the normal version of the 917 racing car. The drag coefficient of the Le Mans winner of 1970 is approximately 0·46. The coefficient of downward pressure is 0·019 on front and 0·351 on rear. It would of course be possible to develop a body shape with a drag coefficient below 0·3 which would mean a top speed of much more than 400 km/h (250 mile/h) for the 630 DIN hp of the 917. However, this value could only be of a theoretical importance as the lack of stability would not permit this high speed even on extremely fast tracks.

The body is not only a housing for the chassis nor a matter of styling. Just as for instance the wheel suspension the body shape is of importance for the road behaviour which will increase with speed and engine power. The body shape cannot be appreciated only in terms of its drag coefficient; the aerodynamic stability has equally to be taken into account. This is also true for racing and production cars.

Test drives with the 917 on a track whose lap times are approximately 1 min 45 s have shown that improvement in lap times of 3 or 4 s can be achieved by body modifications alone. This is a surprisingly high improvement—probably more than a 50 hp increase of engine power would be required to obtain the same improvement.

The 4·5 litre 917 which Porsche used for Le Mans in 1969 had two movable spoilers each at its nose and tail. These spoilers were controlled via the spring movements of the wheels in order to take advantage of all aerodynamic possibilities. If the wheel pressure is reduced, i.e. if the wheel springs are extended, the corresponding spoiler surface becomes steeper, so that the ground pressure is automatically enhanced by aerodynamic forces. These aerodynamic stabilizers become effective in each suspension movement of the cars, such as in curves or when crossing ground waves. Fig. 19 shows this Le Mans version of the 917 car compared with the standard body.

In fact the function of these aerodynamic stabilizers can be described as an attempt to maintain the normal position of a car by making use of aerodynamic forces, i.e. the trim and wheel pressures.

At Le Mans in 1969 a car of this type maintained a leading position until the 21st hour when it had to give up on account of damage in the power transmission.

In 1970 a special 917 car was used at Le Mans besides the normal version. Its body has a drag coefficient of 0·360 and was adapted to the special properties of the Le Mans track. In 1970 movable spoilers were no longer admitted.

The Le Mans track has a criteria which is hardly true for any other track; an increase of the top speed, i.e. a reduction of the drag coefficient, is in this case a better contribution to a lap time improvement than an increase of the permissible transverse acceleration of the car. This is due to the fact that the Le Mans track contains a straight track portion of almost 5 km length, so that the time portion of the curve is only about 16 per cent.

Fig. 20 shows the shape of the Le Mans track and the data calculated in advance by the computer. The encircled figures show which gears are used. Braking is marked by the hatched portions. The computer calculated a nominal lap time of 3 min 19·3 s for the Le Mans type 917. In practice the lap time was 3 min 19·8 s. Theoretically of course the special Le Mans car with a drag coefficient of approximately 0·36 should have won. But in racing there will always be a number of unpredictable events, all the more so if a race lasts for 24 h. Among the unpredictable events of Le Mans 1970 were extraordinarily heavy rainfalls which caused complications at the tyres and the ignition of one car as well as a quite exceptional fracture of a valve spring in the second 917 Le Mans car. The race was won by the 917 shown in Fig. 18. Apart from the changing of the tyre due to the weather conditions this car did not suffer from any difficulties. The car had 21 pit stops for refuelling (oil and petrol) and for changing drivers and tyres. During the 24 h of racing the total pit stops made up 29 min 56 s.

The winning car had travelled a distance of 4608 km (2860 mile) and used 2085 litre (459 Imperial gal.) of petrol, which corresponds to a specific consumption of 45·2 litre per 100 km (6·23 mile per Imperial gal.). Second in the overall classification was also a Porsche 917: the special body car with the ignition difficulties. The small air resistance of this car (drag coefficient 0·36 compared to 0·46) caused a substantially reduced fuel consumption, which was 38·6 litre per 100 km (7·3 mile per Imperial gal.) which won the high-doted consumption index.

Since 1964, when the 904 Porsche was produced in a series of 100, the bodies of Porsche racing cars have been made from fibreglass reinforced plastics. This material is highly suitable for application to racing cars as its production procedure favours the manufacture of small to medium quantities.

A thick-walled shell is made from a positive model in original size in fibreglass tissues and artificial resin and will serve as a model from which the body parts are moulded.

The fibreglass parts of the 917 body and its interior panelling weigh about 42 kg (93 lb).

The development of a racing car is neither easier nor

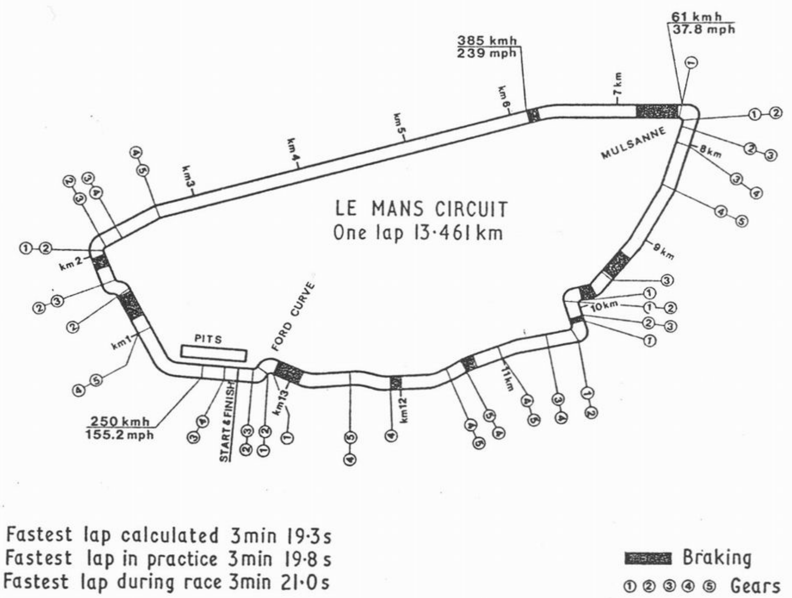


Fig. 20. Computer diagram of Le Mans circuit

more difficult than that of a production car. There is, however, a difference in 'engineering' of the two kinds of cars caused by the different requirements which the racing car, on the one hand, and the production car on the other hand have to fulfil.

Just as the ideal production car, the ideal racing car is an optimum compromise of all requirements.

It is impossible to define the ultimate purpose of automobile racing in one sentence—just as it is impossible to do so for the car in general.

The statement 'the car is a device for transporting persons from A to B' is doubtlessly incorrect or at least incomplete, for if that were all that there is to the phenomenon 'car', then a Rolls-Royce *Silver Ghost* could never have existed.

One extreme is the pure transport vehicle, the other the pure racing car. In between are the cars of people who want to get from A to B. Some of them want to go comfortably, others quickly and others fast and comfortably at the same time.

In the case of a racing car not only the driving but also the designing is fun.

Porsche 917/30 KL of 1973

Specifications

Engine:	Type 912 air cooled flat 12 cylinder. Magnesium alloy crankcase and Aluminium alloy cylinder heads. Titanium inlet valves
Capacity:	5374 cc
Bore and Stroke:	90 mm x 70.4 mm
Maximum Power:	1100 bhp at 8000 rpm
Transmission:	Four-speed synchronised gearbox. Borg and Beck clutch
Chassis:	Multi-tubular aluminium space frame
Suspension:	Double wishbone
Steering:	Rack and pinion
Length:	4562 mm
Height:	730 mm
Wheelbase:	2500 mm
Front Track:	1670 mm
Rear Track:	1564 mm

Main Contenders

A comparative look at the Le Mans winning **Porsche 917** *and the* **Ferrari 512S**

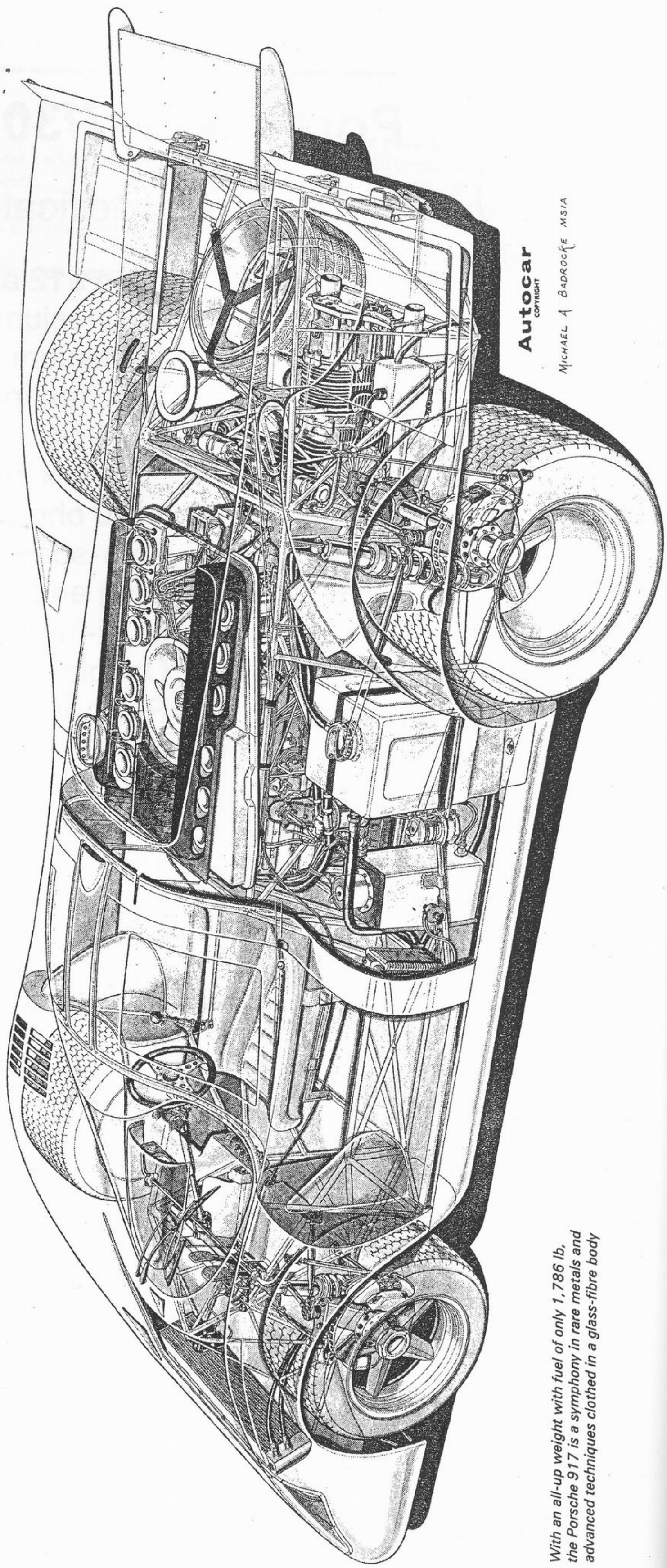
To get round the rules defining sports cars, Porsche and Ferrari each had to build 25 examples if they were to use engines up to 5 litres. The amount of money available implied building cars of great technical interest. Porsche built an ultra-light car with air-cooled engine, Ferrari were more traditional, using a water-cooled vee-12 and readily available materials.

IN 1951 a Porsche 1,086 c.c. lightweight coupé crossed the finishing line at Le Mans in 20th place, behind a Frazer-Nash driven by Dickie Stoop and Peter Wilson and in front of a DB Panhard driven by none other than Rèné Bonnet. This small silver Porsche, propelled by a virtually standard Volkswagen engine, won its class and started a tradition which was to culminate in outright victory for the marque 19 years later. In that race a Ferrari driven by Luigi Chinetti and Jean Lucas finished eighth, covering 177.86 km fewer than Peter Whitehead and Peter Walker's winning C-type Jaguar.

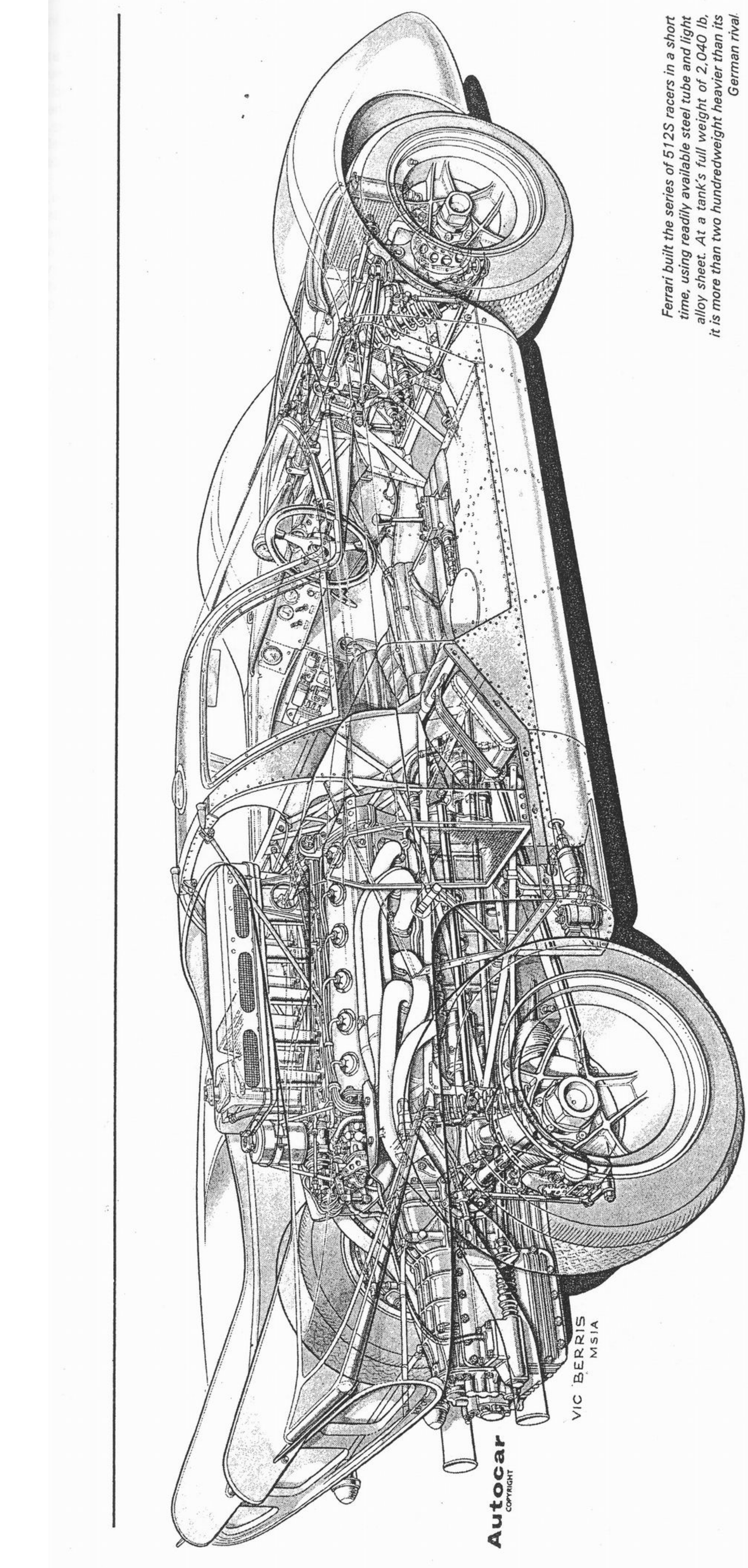
In the intervening years the fortunes of Porsche have climbed steadily through a series of class wins up to places high in the general classification, having a near-win in 1969 and finally ceasing to be the blushing bridesmaid in 1970. In that same period Ferrari have been winners eight times, Jaguar five times, Ford four times, while Mercedes and Aston Martin have one win each.

If ever there was a car built to win a race the 917 is it. Only a few have been sold to promising private owners at a nominal price of £14,000 each. In fact the 25 built to satisfy the Group 5 rules were barely enough to satisfy the requirements of the Porsche racing department. Incidentally, it is quite likely that more than 25 908 prototypes have also been built but no one has bothered to homologate them.

While the Porsche programme has been one of designing increasingly complex cars, year by year, Ferrari have always built cars of about the same degree of complexity; in fact, if anything, they have become more simple. Thus the Porsche which won its class in 1951 was



With an all-up weight with fuel of only 1,786 lb, the Porsche 917 is a symphony in rare metals and advanced techniques clothed in a glass-fibre body



Ferrari built the series of 512S racers in a short time, using readily available steel tube and light alloy sheet. At a tank's full weight of 2,040 lb, it is more than two hundredweight heavier than its German rival.

powered by a near-standard Volkswagen engine driving through a Volkswagen gearbox; many of the brake and suspension parts were also derived from the humble Beetle. The Chinetti 340 Ferrari America, which finished in eighth position, on the other hand, had an overhead camshaft vee-12 engine of 4.1 litres driving a live axle through a Ferrari five-speed gearbox, and by the standards of the day was a complicated vehicle.

In comparing the two rivals for honours in the 1970 race the predominant impression is of the complexity and regardless-of-cost construction of the 917 Porsche and the comparatively down-to-earth way in which the 512 Ferrari is put together. A lot of this had to do with time available to build the cars. In round terms Porsche had one and a half years and Ferrari had less than one. The decision to build a homologated run of 25 cars could only be taken after Fiat had taken controlling interest in Maranello and made the necessary finance available.

The 512 Ferrari, therefore, was built from the most readily available materials. Delivery time for special parts made from rare metals like titanium would have been too long. The chassis design was also kept fairly simple because of the time factor involved in making 25 frames in simple jigs. Mild steel tube is used for the chassis frame on the well-established Ferrari principle of triangulating the structure in the open bays and closing it with stressed Avional panels, attached with pop rivets, to form the floor, firewall, tank sponsons and scuttle. As a safety measure the sponsons are doubled-up.

Although time was at a premium, it will be seen from our drawing that it is quite a complex structure and a lot of attention has been paid to engine mounting, bearing in mind that the engine is intended to help the stiffness of the chassis. Ferrari did not like the usual procedure of fastening the front end of the car to one end of the engine and the rear suspension to the other end of it, as the formula 1 constructors do, because of the racking loads imposed on the crankcase. These can lead to bearing failure. Instead, there are four attachment points at the front ends (to the camshaft covers), one at each side of the block and two at each side of a distance piece to carry the suspension subframe located between the engine and transmission. Thus it will be seen that the spaceframe is extended right back to the rear suspension but gains a lot of support from the engine in the area aft of the firewall. At the same time loads are evenly distributed round the engine.

The Porsche chassis is a pure space frame built up from light alloy tubing by welding. It is debatable whether the few pounds weight saved and the consequent lap times is offset by the loss in driver confidence. That Porsche were aware of this was proved by the device, adopted in early 917s, of filling the frame with nitrogen gas under pressure and locating a pressure gauge in the cockpit so that the driver was aware of a weld breakage by the drop of pressure shown on the gauge. Certainly there were frame breakages in the early days of the 917 and the gauge was necessary, but improvements in welding the multiple junctures of the tubes have made this safeguard unnecessary, and the only reminder of the problem is a union on the frame to which a combined pressurizing and gauging unit can be connected for pre-race checking.

Porsche's answer to the tank fire hazard problem is to use only one tank, located in a glass fibre sponson-shaped box on the right of the driver. Drivers say that handling is not affected by the lopsided weight distribution and a whole maze of crossover pipes and fuel feed pipes are eliminated.

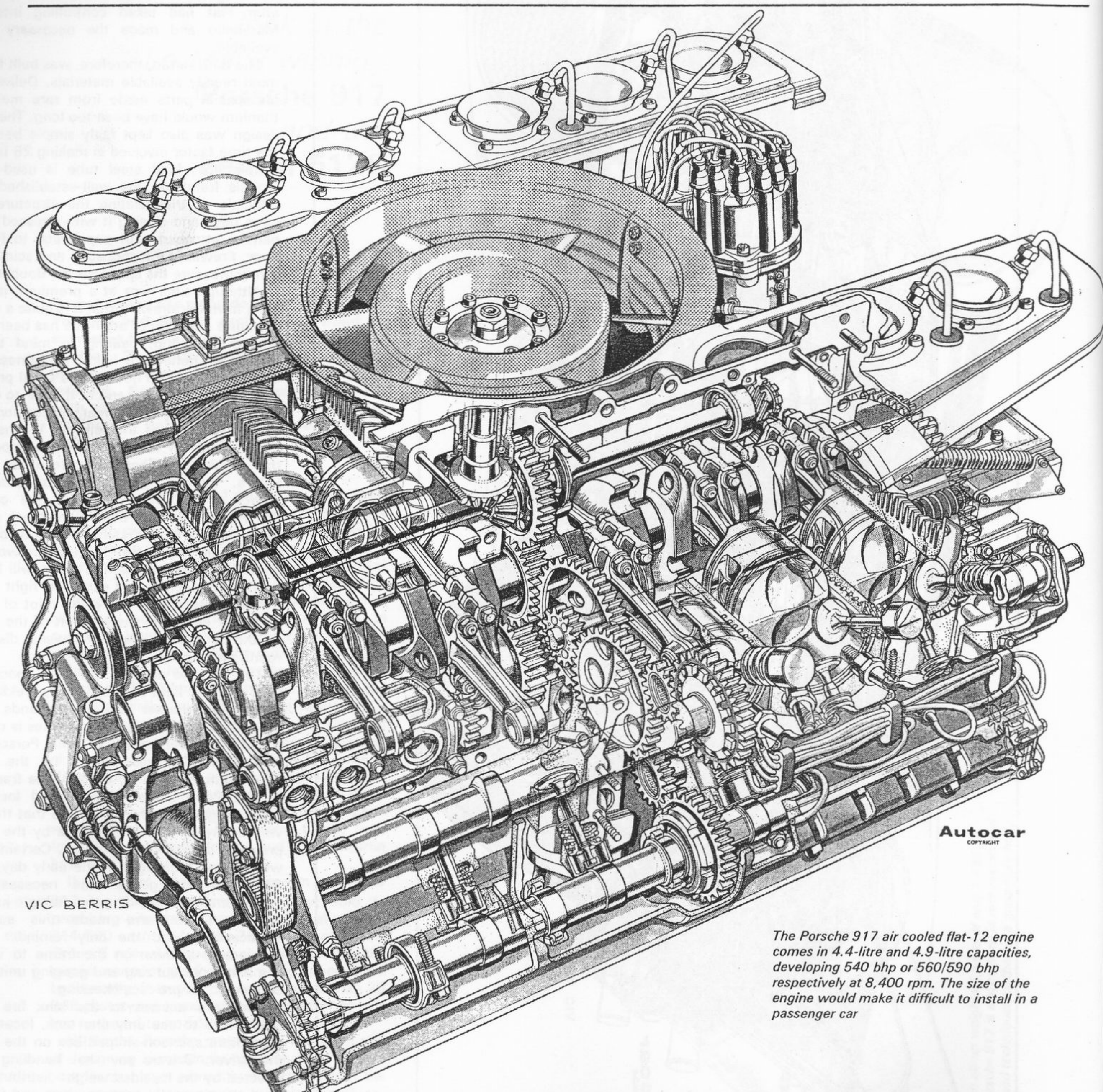
Main Contenders

In contrast with the Ferrari, everything which can be made of titanium for the Porsche is made of that metal. Every nut and bolt on the car is in that material, as are the hubs and hub nuts, the springs, drive-shafts and half the U joints, the steering rods and joints and even the suspension joints.

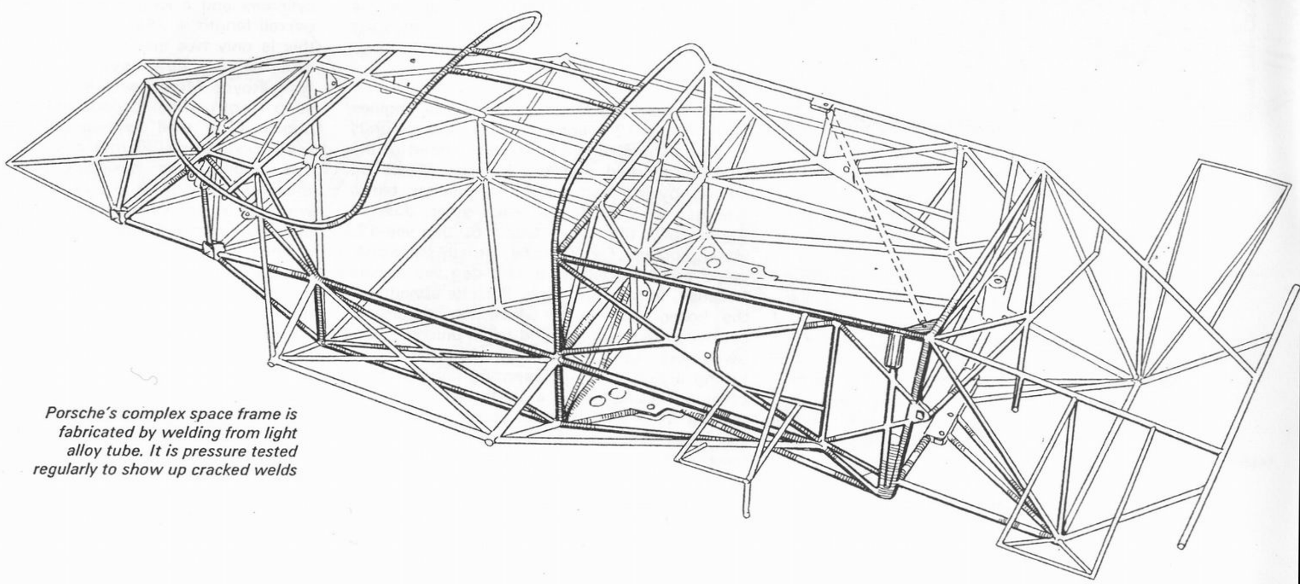
Porsche's investigation into weight saving went as far as to try out beryllium discs. They were not used because the dust from them is so highly toxic, and so incidentally is the swarf when they are being machined. A lightweight compromise was a bonded copper-aluminium-copper sandwich disc, but at Daytona the aluminium "meat" in the sandwich tended to melt. so ventilated cast-iron discs are now the order of the day. Incidentally, as a measure of the thoroughness of the John Wyer organization, the cast-iron discs are now lapped to remove grinding marks. This does away with the need to bed-in linings, an important point saving valuable seconds when discs have to be changed during a race. In the first place the 917 was fitted with Ate calipers, but the Gulf cars and others have been changed to Girling equipment, since the British firm are more in touch with current racing requirements.

Ferrari also use Girling calipers BR 18/4 at the front and BR16/4 at the rear. These have straightforward cast-iron ventilated discs which are sandwiched between the wheel and the hubnut and are located by multiple spigots. Thus they can be changed easily when a wheel is changed; the total time for replacing the discs and the pads is on average 1min.55sec.

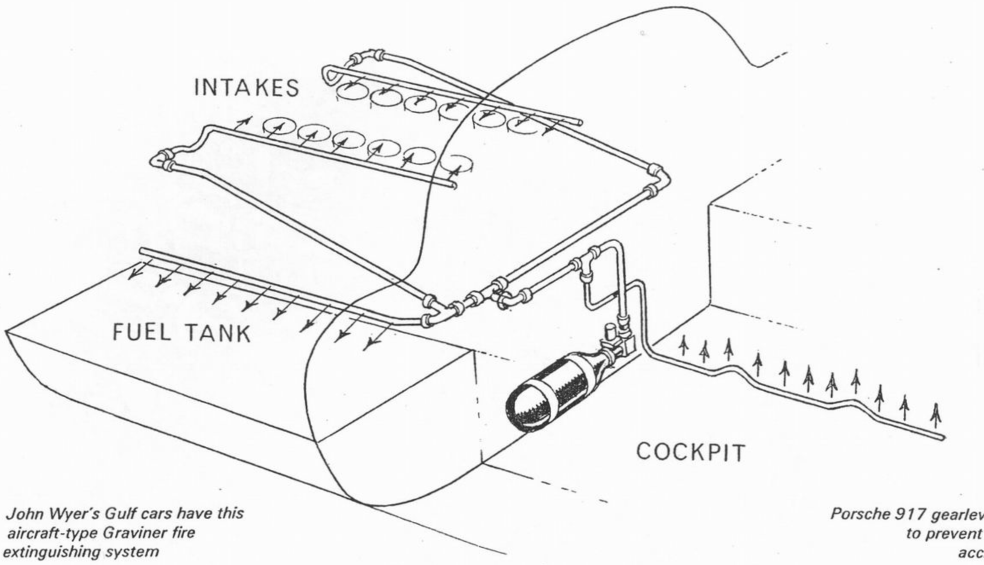
In the general geometry of their suspension, both cars follow the pattern set by the formula 1 constructors, with unequal length wishbones at the front and the so-called four-link layout at the rear. To arrive at this unanimous decision on rear suspension, Porsche have worked through swing axle and trailing link layouts to



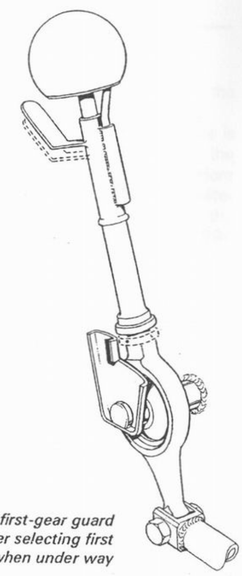
The Porsche 917 air cooled flat-12 engine comes in 4.4-litre and 4.9-litre capacities, developing 540 bhp or 560/590 bhp respectively at 8,400 rpm. The size of the engine would make it difficult to install in a passenger car



Porsche's complex space frame is fabricated by welding from light alloy tube. It is pressure tested regularly to show up cracked welds



John Wyer's Gulf cars have this aircraft-type Graviner fire extinguishing system



Porsche 917 gearlever, with first-gear guard to prevent the driver selecting first accidently when under way

the present set-up, while Ferrari started with a live axle mounted on coil springs and have raced with de Dion as well as wishbone rear ends. In common with that of the Porsche their present set-up is adjustable for camber and toe-in.

At the front the Porsche wishbone geometry is arrived at with an arrangement of tubular rods and CHAG Rose-type joints. The Ferrari layout appears to be more robust, having welded tubular wishbones with the wheelpost swivelling on large diameter ball joints. The upper wishbone pivots are plain bushed, while the lower rear pivots are relics of the old D50 Lancia, having a ball socket retained by a triangular plate.

Both cars have glass-fibre bodies, that of the Porsche being a thin envelope enclosing the whole space frame with a series of panels, while that of the Ferrari consists of a tail cone and a nose cone attached to a mainly metal centre section. Both constructors use the principle of detachable nose and tail pieces carrying a whole armoury of different shapes to experiment with or to suit different circuits. For example. at the Nürburgring the 917s were tested—the 3-litre 908s were used in the race, being more suitable for this circuit—with pelmet type noses and flat deck tails, while for Le Mans the double sweep "dolphin" body was developed. This was finalized only just in time, as it transpired. Experimental cars with this body shape were being written off at a rate of knots until someone suggested putting a fixed airfoil between the fins.

An interesting feature of the Porsche body is the rear exhaust duct necessitated by the tail being longer than the ideal exhaust pipe length. This titanium-panelled plenum chamber carries exhaust fumes back to a point where they could not be sucked back into the engine compartment and cockpit. A minor aerodynamic refinement in this area was to duct the engine cooling exhaust air to a low pressure area under the car where it helps to reduce drag.

It is likely that Ferrari had insufficient time to develop the best shape for their bodies. However, thanks to help from their parent company, Fiat, who, being owners of *autostrada,* closed one for full speed testing of the 512S, a shape of body was developed which did not lift at high speed. This was the Le Mans longtail coupé which is remarkably clean looking compared with the short tail type that is the subject of our cutaway drawing. However, with 600 bhp available, the Ferrari was not as fast on the Mulsanne straight as the 560 bhp Porsches with either type of body. For those who are prepared to do sums, the Ferrari had about the same straight-line speed as the old GT40, namely 205 mph, and we know that the GT40 had a C_d of 0.380 and at the top of form the engine was giving 425 bhp.

The lightest Ferrari 512S coupé at Le Mans weighed 2,019 lb and the lightest Porsche, the winner, weighed 1,786 lb. This two hundredweight handicap on a car which had exactly the same power available as its rival must have inhibited its chances of winning a race. However, the weight distribution of the Porsche, with twice the weight on the rear wheels, as on the front, 1,332 and 659 lb respectively, would theoretically make it more of an oversteerer and more difficult to drive

Main Contenders

than the Ferrari, which had 60 per cent of its weight on the back wheels. Moreover, because the vee-12 engine is shorter the driver sits further back in the car and is better placed to sense what is going on. In practice the Ferrari is reported to be very heavy to steer, inducing driver fatigue after a short time while the Porsche is easier on the driver.

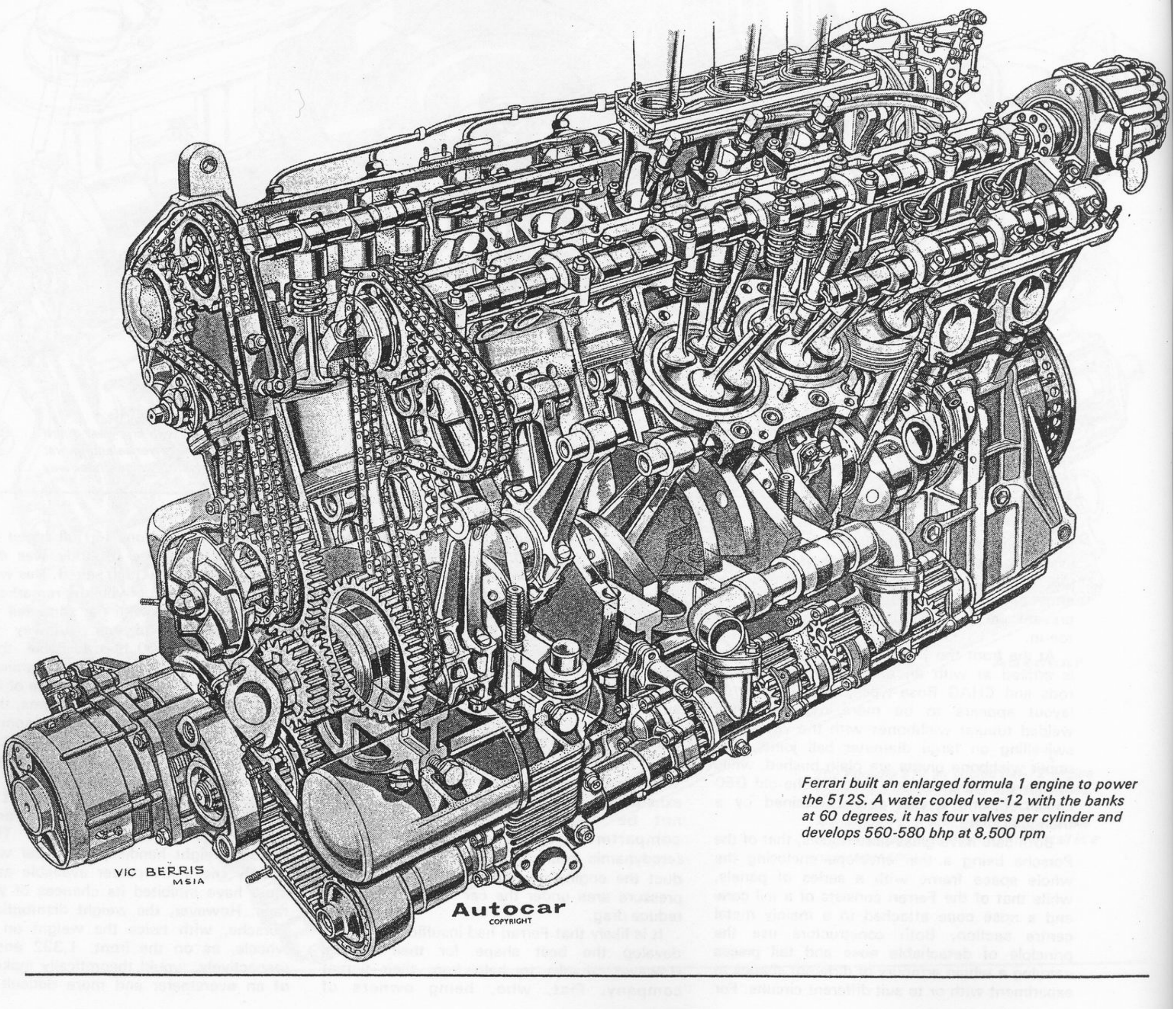
Because of the need to destroy lift with spoilers none of the Le Mans cars are particularly "clean". At the start of the season the flat deck Porsche had a C_d of 0.46 tested in a full size tunnel, a figure which had been improved to 0.42 by the time of Le Mans. This improvement was worth 10 mph. The Porsche works claim the remarkably low figure of 0.25 for the long tail "dolphin" body, based on wind tunnel tests with a quarter scale model. On this figure they based their claim for 250 mph down the straight; this in practice proved to be 220 mph, suggesting a higher coefficient of drag with the full-size car. Actually its lap speeds were only one-tenth of a second faster than the short-tail car.

Power

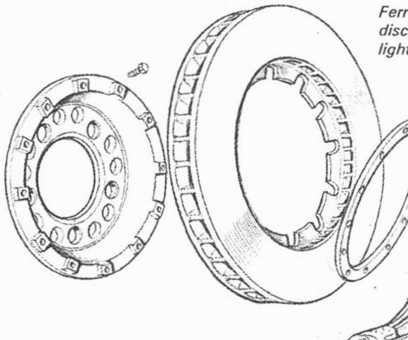
Apart from the Porsche and Ferrari engines each having 12 cylinders, no two power units could be more different. It was a tenet of the Wolfsburg creed that the Porsche should be cooled by air and have the cylinder banks arranged at 180 deg to each other. Just as traditionally, the Ferrari was a 60 deg vee-12, water cooled. The Porsche, strictly speaking, could be described as a 180 deg vee engine because, for the first time, Porsche abandoned the boxer principle in which the pistons of opposing cylinders rise and fall in unison, going away from each other and coming together in a boxing action. Instead, opposing pistons share common crankpins on a six-throw crankshaft, making for a more simple, sturdy engine than the boxer unit with a 12-throw crank would have been. Incidentally, a main disadvantage of this layout is that the crankshaft big end inertia loads are doubled because two pistons and connecting rods have to be stopped and started by a single crankpin.

Cylinder spacing is determined by the need to allow a decent air space between the cylinders and a long engine is inevitable. The overall length is 34in.; as a matter of interest this is only two inches shorter than the block and timing gear section of a 22-litre Rolls-Royce Merlin aero engine. The need to keep length within bounds did not inhibit the choice of a well over-square bore-to-stroke ratio, bore being 85 mm and stroke 66 mm. The engine was designed to develop its maximum power at 8,500 rpm, a speed at which two large valves per cylinder—the inlets are 47.5 mm diameter—will operate without bounce.

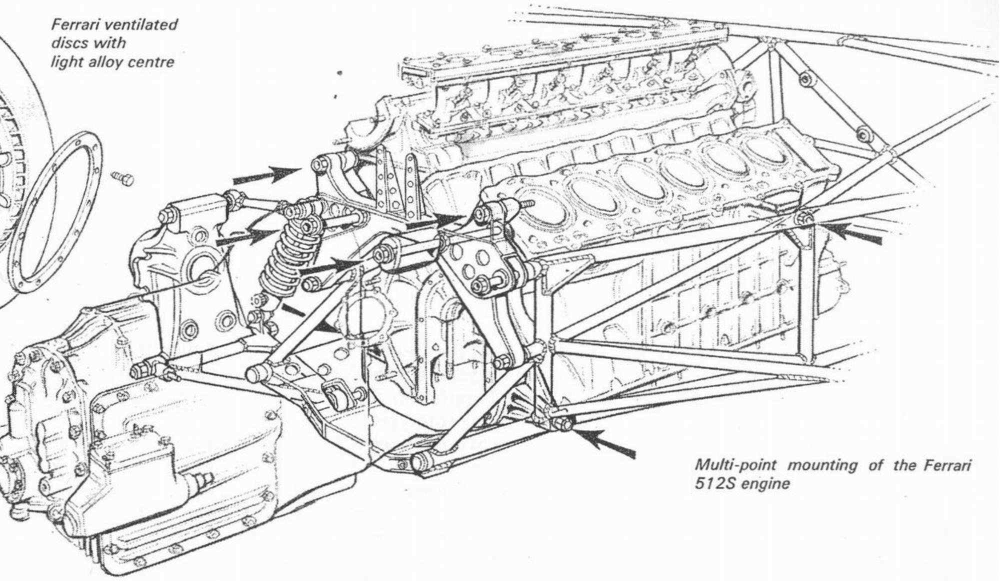
The valves are operated by two overhead camshafts per bank through the medium of bucket tappets, these latter another innovation for Porsche who have hitherto favoured finger operation for their camshaft engines. The valves are set at the old-fashioned angle of 65 degrees, mainly because of their size and the need to get air between the stems. Nevertheless the engine gives 520 bhp at 8,450 rpm while the "5-litre", 4,907 c.c. unit with a bore and stroke of 86 mm and 70.4 mm gives 560-590 bhp at 8,400 rpm. Bosch port injection supplies the mixture, which is fired by two plugs per cylinder. A quaint feature of the Bosch transistor ignition is the large wooden-



Ferrari built an enlarged formula 1 engine to power the 512S. A water cooled vee-12 with the banks at 60 degrees, it has four valves per cylinder and develops 560-580 bhp at 8,500 rpm

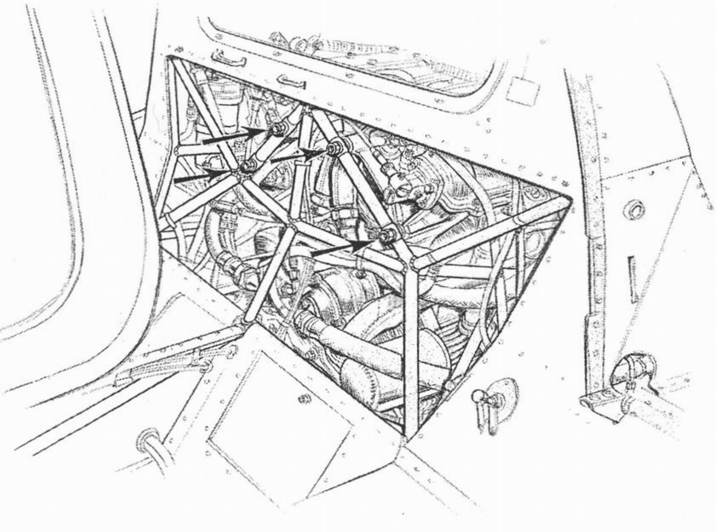


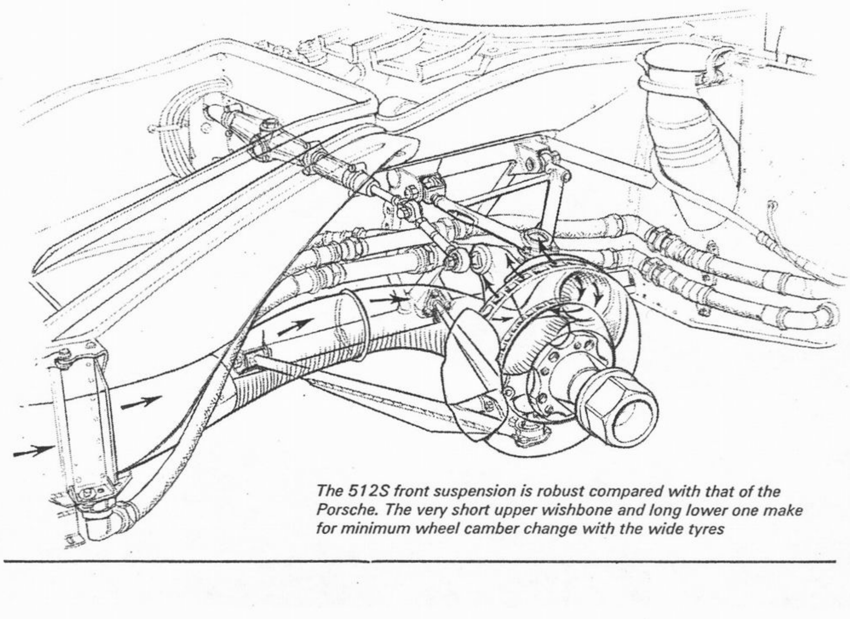
Ferrari ventilated discs with light alloy centre



Multi-point mounting of the Ferrari 512S engine

Front attachment of the Ferrari engine to the firewall spaceframe





The 512S front suspension is robust compared with that of the Porsche. The very short upper wishbone and long lower one make for minimum wheel camber change with the wide tyres

framed ballast resistors mounted on the firewall.

A drawback with the large Porsche engine is that it pushes the driver farther forward in the car than is good for his sense of feel. Here Ferrari are at an advantage, for their water cooled vee-12 is appreciably shorter than the Porsche unit despite its larger capacity of 4,994 c.c. (87 x 70 mm). Many of the lessons learnt in formula 1 racing have been applied to its design. The double overhead camshafts are chain driven from the front of the crankshaft by way of a pair of half-time wheels, in contrast with the Porsche camshaft drive which is from the middle of the crankshaft by gears. Each cylinder bank has a single camshaft cover with spark plugs, one per cylinder, inserted through tubes. The valves, four per cylinder, are inclined at an angle of 25 degrees, the inlets drawing their mixture through manifolds cast integral with the heads. Lucas fuel injection supplies the mixture, the fuel distributor being driven off the end of the right hand inlet camshaft. The best engines give 590 bhp at 8,500 rpm, with good power from 4,000 rpm.

An idea which is gaining in favour is to mount the oil pressure and scavenge pumps on the outside of the crankcase where they are easily accessible for servicing or for modification without stripping the engine. It also makes for a more compact, symmetrical crankcase. On the 512S engine the pumps are mounted on the left of the crankcase in tandem and are driven by a cog belt from the crankshaft nose.

Power from the engines of both cars is transmitted by a Borg and Beck clutch to a five-speed gearbox. However, on the Le Mans Porsches, this number was reduced to four in the interests of reliability. It will be recalled that a number of transmission failures eliminated the 917s in the 1969 Le Mans race. This was due to bell housings cracking, a fault which has been overcome by polishing the housings to eliminate stress raisers.

Alongside the Porsche the Ferrari looks a conventional car and the asking price £18,000 seems a realistic one. Certainly it has the makings of a road car, which is rather more than could be said for the Porsche which was designed with one end in view—to win at Le Mans. □

THERE'S GENERALLY a big surprise at the Geneva show, but very rarely is it a racing car. This year, for the 39e Salon Auto Genève, it was two—the Pininfarina Sigma safety Grand Prix car and the big new Porsche prototype.

The first of these, the Sigma, is a hypothetical Formula 1 car built around a Ferrari V-12 engine, suspension and wheels, incorporating numerous safety devices intended to render racing a lot less dangerous than it is. Sponsored by the Swiss journal *Automobil-Revue,* and produced by Pininfarina with the aid of Ferrari, safety specialist Dr Michael Henderson (author of *Motor Racing in Safety*), retired driver/journalist Paul Frere, and Professor Dr Ernst Fiala of Berlin Polytechnic, with technical advice from Fiat and Mercedes-Benz, the Sigma is pure hypothesis—preventive medicine, one might say—and as such deserves close investigation.

Meticulously designed harnesses restrain movement of the driver's body, neck and head in the event of collision; crash-resistant, self-sealing fuel tanks, Graviner automatic fire extinguishers and 2-layer flame-resistant overalls reduce fire risk; an all-enveloping body gives good lateral protection and prevents the wheels from tangling, wheel fairings diminish spray effects in wet conditions, an inertia-operated master switch cuts all electrical circuits, and a "black box" records all acceleration forces, etc., involved in a crash for subsequent reference. With its nose fairings spreading out of full wheel width, and impact-absorbing side fairings with fuel tanks behind them, the Sigma is good looking, if heavy, though a body-mounted airfoil spoils the clean lines.

Jackie Stewart, taking a look, asked "Where will you put the front airfoil?" to which Mike Henderson replied "Sergio Pininfarina doesn't like front airfoils." He doesn't like them admidships either, but made the best of this one by making it serve also as a roll-over bar, while its present position is the only possible one on a production road car.

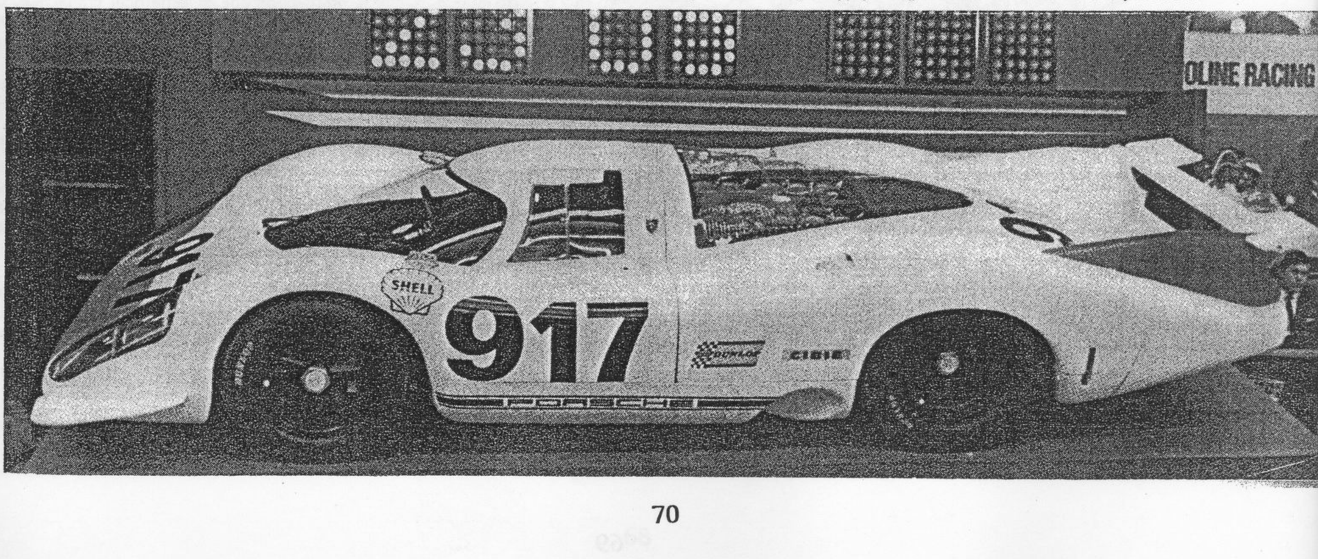
THE OTHER show-stopper at Geneva was the new Porsche 917. "Seems like they mean Ford to get stuffenhausen by Zuffenhausen at Le Mans this year," one disrespectful voice said at the German's surprise launching of the 4.5-liter 12-cyl sports prototype.

Rumors of the big Porsche had been flying around for days but not many people outside the Zuffenhausen works and maybe the offices of the Syndicale Suisse de l'Automobile knew that it would appear at the Geneva Show. It wasn't on the company's stand, but in the competition car section where it made most other attractions seem pretty secondhand. Its low hood, packed full of goodies, would have warmed the cockles of old Herr Doktor Ferdinand Porsche's multi-cylinder heart, for this Porschissimus of Porsches comes close in broad specification to his prewar Grand Prix Auto Unions, and even closer to his last racing design, the flat-12 Cisitalia of 1949.

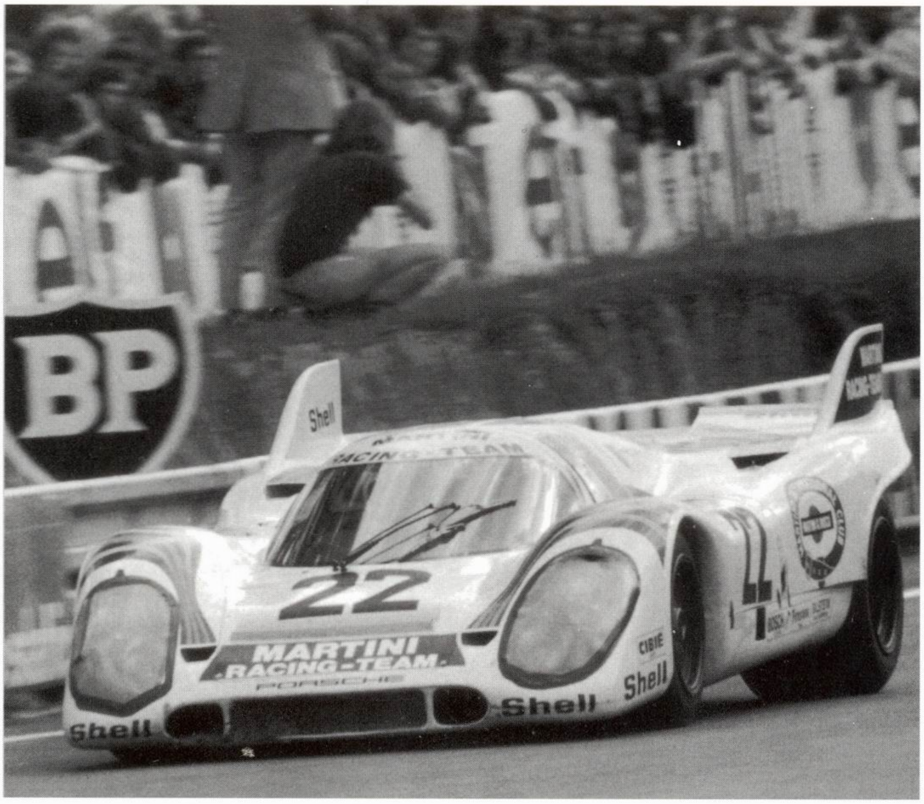
Not that the new Porsche "sports car" is a single-seater, of course, but it might as well be, for the Sifferts, Elfords, Stommelens and Mitters of this world won't want company while grappling with the 520 bhp of this Group 4 bolide. Yes, Group 4, where Ford and Lola and, this year, McLaren as well should sport for the honors, for Porsche will already have built 25 examples of the *Zwölf,* and secured FIA homologation, by the time this appears in print; and we gathered that its first race would be the BOAC 500 at Brands Hatch.

Geoff Goddard's photos show what the 917 looks like—long, low and sleek, with the engine mass pushing the driver further forward than in a 907 or 908. Not much of the 12-cyl aircooled "boxer-motor" could be seen at Geneva, apart from a long double row of plastic intake trumpets and a large horizontal plastic fan, prompting one unbeliever to wonder if the block and crankcase might not be plastic too! Bore and stroke are 85 mm x 66 mm, giving a displacement of 4494 cc, which in turn gives 520 bhp DIN at 8000 rpm by courtesy of twin overhead camshafts to each block, dry sump lubrication, 10.5 to 1 compression ratio, Bosch fuel injection, 12-volt transistor ignition and, of course, the full Porsche black magic.

Externally similar to 1968 long-tailed 907, Porsche's 4.5-liter 917 flat-12 will qualify for Sports class when 25 are finished.



PORSCHE
917



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